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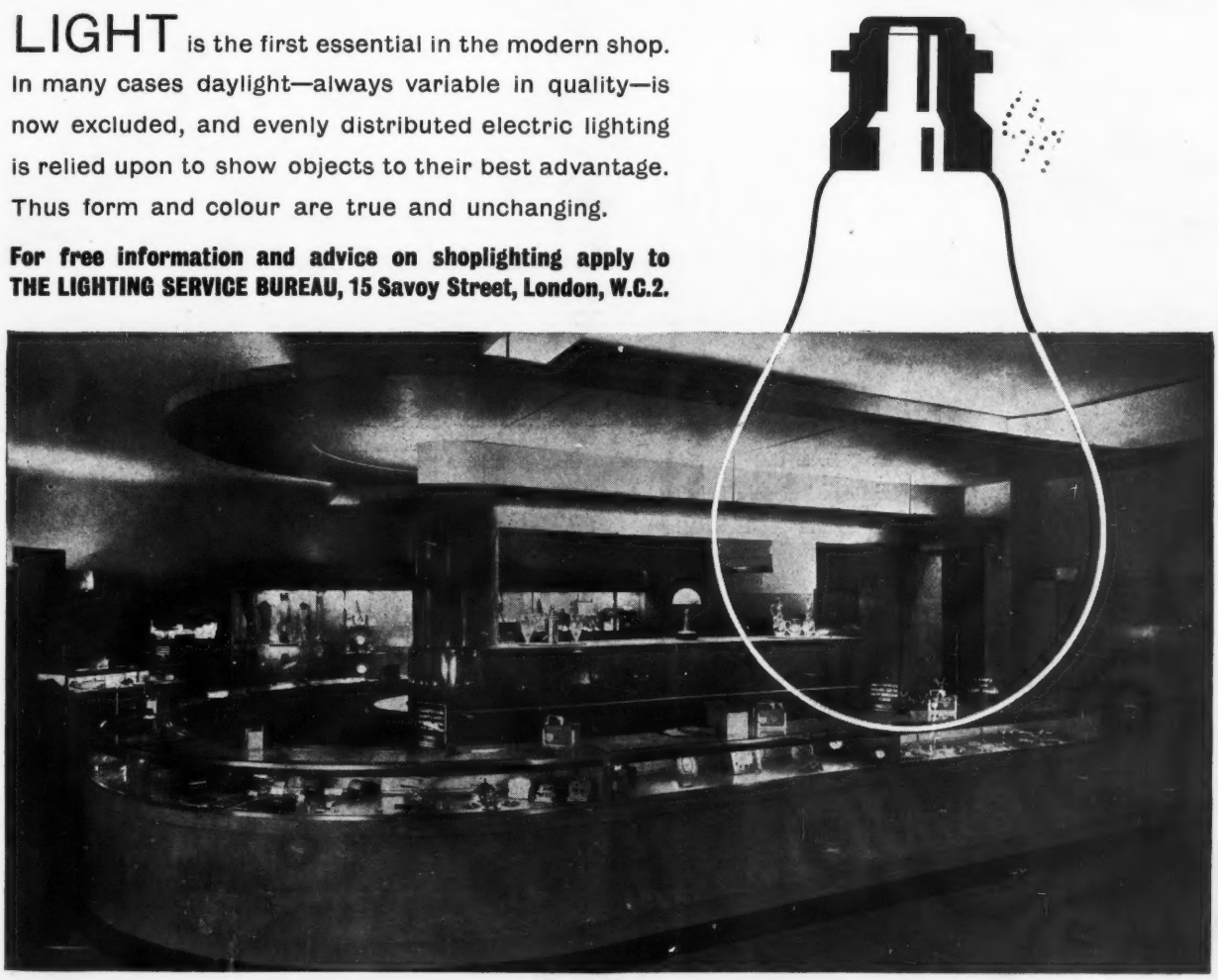

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The Historical Development of Artificial Lighting

THE meeting of the Illuminating Engineering Society in the hall of the Tallow Chandlers' Company, on November 18th, was, as Mr. C. C. Paterson remarked, a red-letter day in the history of the Society, as well as an extremely pleasant event. Mr. H. S. Monier-Williams gave a fascinating account of the development of the Tallow Chandlers' Company and their craft, Mr. W. J. A. Butterfield surveyed, in a delightful manner, the development of gas lighting, and Mr. J. Swinburne, who discoursed on early days of electric lighting, did so with the touch of a master. It was a happy idea—for which, we understand the Society had to thank Mr. C. C. Paterson, himself a member of the Tallow Chandlers' Company—to hold a meeting in such an interesting environment, and the vote of thanks tendered for this hospitality at the conclusion of the meeting had the hall-mark of sincerity.

It is always instructive to dig into the past history of artificial lighting, and the three addresses were, each in different ways, suggestive. One gathered from Mr. Monier-Williams's address how tenacious the tallow chandlers were in defence of their rights and how painstaking in the preparation of specifications relating to their products. Looking still further back, we find the Guild of Wax Chandlers likewise preparing an elaborate specification and presently struggling desperately against the introduction of the tallow candles (the relative costliness of tallow and wax being at that time in the ratio of 1 to 15). Whilst for a long period the candle retained its supremacy as the sole effective means of illumination, this in turn was threatened by the oil lamp, and the latter by the introduction of gas lighting. Each new illuminant has inevitably had to face the opposition offered to innovations by old-established concerns. Yet in the long run the new conditions have proved less ruinous to the older industries than was feared. Mr. Dumoncel, in an early work on electric lighting, remarked: "The producers of lamp oil were at this time struck with dismay, for in this discovery they saw the ruin of their industry. But they soon found that, contrary to their expectation, the consumption of lamp oil increased with the development of gas illumination. It could not indeed be otherwise, for gas illumination by accustoming people to a brighter light was bound to lead to an increase in the number of lamps for private illumination." It would, perhaps, be injudicious to carry this reasoning too far. But the fact remains that even in these days of efficient gas and electric lighting many oil lamps and candles are still sold. The candle, indeed, still retains a unique position in virtue of its simplicity, and there is truth in the remark that if it were now invented for the first time it would be hailed as the most wonderful discovery of the century!

It is also instructive to observe how each illuminant, in turn, has paved the way for the other. The difficulties experienced by pioneers of electric lighting were sufficiently formidable and confusing. (Mr. Swinburne illustrated the vagueness of thought associated with the famous phrase "the subdivision of the electric light.") But these difficulties would have been infinitely greater but for the existence of gas lighting, which had familiarized the public with the idea of conveying means of illumination to a distance. Each illuminant, too, has been of genuine aid to the cause of better lighting by affording stimulus to its rival. Modern gas lighting would have been something very different had there been no electricity; nor would electric lighting have developed so far but for the rivalry of gas; both these illuminants have helped to stimulate improvements in the modern oil lamp which, in country districts, has proved itself a mode of lighting by no means easy to displace.

Most significant of all is the rising standard of artificial illumination to which people have become accustomed. The principle that relatively high illuminations do facilitate speedier and more accurate work, at least in the case of fine operations, is now generally conceded. But the change goes further than this. People are no longer content even to sit in a room lighted to a degree that would have seemed adequate to a past generation. City folk, accustomed to gas and electric lighting, would find it impossible to read or sew by the feeble illumination still occasionally found in remote districts where candle-light is still the rule. We do not know conditions are bad until we see how much better they might be.

Illuminating Engineering Society

Annual Dinner.

Members are reminded that the Annual Dinner of the Illuminating Engineering Society is to be held at the Trocadero Restaurant, Piccadilly, London), on the evening of Tuesday, February 9th—the anniversary date of the foundation of the Society. A diminution has this year been found possible in the price of tickets (12/6, exclusive of wine) and the arrangements will resemble those that proved so successful last year. Applications for tickets should be addressed to the Hon. Secretary (Mr. J. S. Dow, 32, Victoria Street, London, S.W1.), not later than January 30th.

Literature on Lighting

(Abstracts of recent articles on Illumination and Photometry in the Technical Press)

(*Commencement of New Series*, 1932.)

Abstracts are classified under the following headings: I, Radiation and General Physics; II, Photometry; III, Sources of Light; IV, Lighting Equipment; V, Applications of Light; VI, Miscellaneous. The following, whose initials appear under the items for which they were responsible, have already assisted in the compilation of abstracts: Miss E. S. Barclay-Smith, Mr. W. Barnett, Mr. S. S. Beggs, Mr. F. J. C. Brookes, Mr. H. Buckley, Mr. H. M. Cotteril, Mr. J. S. Dow, Dr. S. English, Dr. T. H. Harrison, Mr. C. A. Morton, Mr. G. S. Robinson, Mr. W. C. M. Whittle and Mr. G. H. Wilson. Abstracts cover the month preceding the date of publication. When desired by readers we will gladly endeavour to obtain copies of journals containing any articles abstracted and will supply them at cost.—ED.

II.—PHOTOMETRY.

1. Photometric Sensitivity. R. G. Weigel.

Das Licht, 12, 315; *and* 13, 339, 1931.

Results on photometric sensitivity throughout the spectrum from 500 to 650 mμ with various sizes of photometric fields are given in the form of curves. Using a brightness of about 60 lux in white light, a balance against yellow light could be obtained to an accuracy of about 2 per cent., and against red and green to between 2 and 5 per cent. The use of a flicker device for heterochromatic photometry was also investigated. S. E.

2. An Automatic Recording Photo-electric Cell Distribution Photometer. W. F. Little and H. J. Eckweiler.

Am. Illum. Eng. Soc., Trans. 26, *pp.* 810-819. Oct., 1931.

The two-mirror gear is rotated by means of asyncronous motor through reduction gearing. For the measurement of intensity a thickly coated cæsium cell is used with a Wheatstone-bridge connection of valves. A slightly greenish filter corrects the response curve of the photo-electric cell to the visibility curve. Photographic recording on various co-ordinates is possible, and the unit under test may be rotated in order to obtain automatically a mean value of the intensity. G. H. W.

III.—SOURCES OF LIGHT.

3. Overrunning Life Tests on Electric Lamps and the Accuracy of Correlated "Life" Calculations. L. Prásnik.

Das Licht, 12, 313; *and* 13, 337. 1931.

A discussion of the possibility of using accelerated life tests on lamps by using voltages higher than the standard for the lamps, and then reducing the normal life by means of an empirical equation of the type $\frac{L_0}{L} = \left(\frac{V}{V_0}\right)^n$. S. E.

4. Coloured Light Sources for Stage Illumination. R. Rompe.

Das Licht, 13, 335. 1931.

During recent years gaseous-discharge lamps have been so improved as to find increasing practical applications in lighting technique. They give line spectra, from which it is possible to produce coloured lights much more economically than from ordinary filament lamps, e.g., for red a neon tube is used; for green a mercury tube is used in conjunction with a glass that absorbs blue and violet; for daylight blue a mercury tube is used together with a Schott's filter, m.b.g.7. It is suggested that better results may be obtained by using tubes containing cadmium or zinc vapours. S. E.

IV.—LIGHTING EQUIPMENT.

5. Portable Searchlight. Anon.

Elect., 107, *p.* 825. *Dec.* 11, 1931.

A brief reference is made to a recently developed portable searchlight, the reflecting surface of which is of special construction to make it possible to locate an aeroplane in the sky and to determine its height, speed and direction. A photograph indicates the type of beam resulting. C. A. M.

6. Lightstrip. H. G. Schiller and W. E. Clemson.

Light, 2, *p.* 32. *Nov.*, 1931.

A short description, with photograph, is given of a new striplight unit developed in America to accommodate a special tubular lamp. A series of small polished aluminium trough reflectors with lampholders is secured in a long metal channel housing by means of small friction grooves in the channel. C. A. M.

7. Recent Developments in the Preparation of Prismatic Glass for Lighting Purposes. S. English.

Das Licht, 12, 293. 1931.

The problem of producing a glass of good colour for street-lighting purposes and capable of withstanding the tendency to discolour when exposed to the sun in service is discussed. Curves are shown indicating the effects of natural and artificial ageing on the efficiency of street refractors made of different types of glass.

The development of heat-resisting properties and the power to withstand the corrosive action of unfavourable atmospheric conditions are also discussed. S. E.

8. Recent Developments in Optical Glass Manufacture. W. M. Hampton and W. N. Wheat.

Nature, *Vol.* 128, *p.* 926. *December 5th*, 1931.

Describes the recent developments and technique necessary in the production of the more extreme types of optical glass called for in modern lenses. J. M. W.

9. A Power Plant that Flies. R. E. Hudson.

Electric Journal, *Vol.* 28, *No.* 11, *p.* 605 *Nov.*, 1931.

Describes the electric and lighting equipment of the U.S.N. airship "Akron." J. M. W.

V.—APPLICATIONS OF LIGHT.

10. The Present Position of Street Lighting by Gas. F. Schäfer.

Das Licht, 12, 296; 13, 322. 1931.

After a historical introduction, various types of gas burners are described and polar curves of light distribution from typical burners are given. By light-controlling devices, as used for electric street lighting, combined with special burners various types of light distributions are obtained, e.g., intensive, extensive and directional. S. E.

11. The Lighting of Motor Roads. H. Lingenfelser.

Das Licht, 12, 299. 1931.

Experiments are described, which were carried out with a model street constructed on a 1/10 scale. The materials forming the road surface had reflectivities ranging from black, through grey, to nearly white. Spacings equivalent to 11 ins., 14.5 ins. and 18 ins. were used, and intensities of 2.79, 1.96 and 1.48 lux were obtained, with inequality ratios of 1 : 4.3, 1 : 6.9 and 1 : 11.4. S. E.

12. Saving Social Waste by Better Street Lighting. T. W. Rolph.

Am. Illum. Soc., Trans., 26, *pp.* 787-809. *Oct.* 1931.

The author presents statistics covering the economic and social wastes caused by poor street lighting, which are due primarily to traffic accidents and crime; and continues with a suggested outline of a street-lighting programme whereby adequate street-lighting service may be made available to cities of various sizes, so that both present and future requirements may be met. The many factors involved in providing satisfactory street lighting are presented and discussed in detail. G. H. W.

13. The New Ballroom at Claridge's. Anon.

El. Rev., 109, *pp.* 875 *and* 898. *Dec. 11th*, 1931.

A page of illustrations shows the excellent modern lighting adopted at Claridge's Hotel extension. The main lighting is cornice lighting, together with artistic wall brackets, mirrors, and a new type of diffusing illuminated glass which gives a remarkably soft effect. G. S. R.

14. Floodlighting Development. H. E. Hutter.

El. Rev., 109, *p.* 827. *Nov. 27th*, 1931.

The latest development in floodlighting technique is the blending and changing of colours. In a multi-coloured installation the brighter colours should predominate, as this gives a brighter general tone to the whole scheme. The light transmissions for the different colours generally used are:—

Colour:	Red	Green	Blue	Amber
Transmission per cent.	10-20	10-16	3-5	50-60.

An illustration of such an installation is the Rand Building. A photograph is given. This installation employs 166 kilowatts total energy. G. S. R.

15. Pit Lighting Problems. Discussion.

El. Rev., 109, *pp.* 810-11. *Nov. 27th*, 1931.

For good lighting in coal pits considerably increased illumination is desirable over present standards. This would give increased output with cleaner coal. Such an increase in illumination is impossible under present regulations. A most satisfactory way would be a 12-volt A.C. supply run up to the pit face with lamps spaced every 10 to 20 yards. G. S. R.

16. Interim Report : Committee on Light in Architecture and Decoration.

Am. Illum. Eng. Soc. Trans., 26, *pp.* 785-786. *Oct.*, 1931.

After two comments by designers, ten modern installations are described with photographs. G. H. W.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

Historical Developments in Lighting

Proceedings at a Meeting held in the Hall of the Worshipful Company of Tallow Chandlers (4. Dowgate Hill, London, E.C.4), at 6-30 p.m., on Wednesday, November 18th. 1931.

THE third meeting of the session was held by kind invitation of the Worshipful Company of Tallow Chandlers, in their Hall, at Dowgate Hill, on Wednesday, November 18th. Members, on arrival at 6-30 p.m., were welcomed by the Master, and were entertained to tea until 7 p.m., when the meeting began, and the chair was taken by Lt.-Col. Kenelm Edgcumbe (Past President).

In opening the proceedings THE CHAIRMAN explained that a message had been received from the President (Sir Francis Goodenough) expressing his great regret at inability to attend owing to urgent business which had compelled his absence from town.

The minutes of the last meeting having been taken as read, the names of the following applicants for membership were presented:—

Sustaining Member:—

Bournemouth Gas and Water Co., to be represented by Mr. Philip G. G. Moon, 136, Old Christchurch Road, Bournemouth.

Corporate Member:—

Best, A. H.....5, Endlesbury Road, Chingford, London, E.4.

The Hon. Secretary also read again the names of applicants presented at the last meeting,* and these gentlemen were formally declared members of the Society.

The CHAIRMAN then expressed the great pleasure which members all felt at being allowed to hold a meeting in the historic hall of the Tallow Chandlers' Company. It had been thought appropriate on such an occasion to arrange for three addresses

* *The Illuminating Engineeer*, December, 1931, page 303.

surveying the development of lighting with candles, gas and electric light. He would first call upon Mr. R. H. Monier-Williams, Clerk to the Company, to read his address entitled "The Tallow Chandlers' Company and their Craft."

Mr. R. H. MONIER-WILLIAMS then gave an instructive and interesting address (see pp. 5-7) tracing the development of the Tallow Chandlers' Company, whose craft was first mentioned in 1233, although it did not receive official recognition until more than 100 years later, whilst in 1462 the Company obtained from Edward IV their Charter of Incorporation. The site of the present hall was purchased in 1476. In 1672 the hall was rebuilt, after the first one had perished in the Great Fire of London, in which form it has remained until to-day. Subsequently the speaker dealt in some detail with the rules governing the manufacture of tallow candles, with the obligation imposed on householders to install lanterns outside their doors, and with complaints raised against the use of "convex lamps and other lucidiaries," which were considered injurious to the trade. It was in 1472 that the Westminster Paving and Lighting Act was passed and the days of the lamplighter began.

Mr. W. J. A. BUTTERFIELD, who then delivered his address on "The Historical Development of Gas Lighting" (see pp. 8-10), referred in his opening remarks to the address on this subject delivered before the Society by Capt. Liberty in 1913. He traced the development of gas lighting from the days when Murdock lit up his house in 1792 and his Soho factory in 1802, dwelling on the great difficulties which early pioneers had to overcome. He pointed out that gas is the modern counterpart of the candle, since both are flame illuminants, how the introduction of electric lighting had but served to stimulate the rival illuminant to greater efforts, and how the invention, first of the upright and then the inverted burner and mantle, had led to a great advance in efficiency. The final section of the paper dealt with the more modern developments, such as methods of raising the temperature of the flame, of using groups of mantles in the same lantern, and of devising improved means of controlling gas lights from a distance.

Mr. J. SWINBURNE, who then dealt with "The Early History of Electric Light" (see pp. 11-12), recalled the first efforts of electric lighting with arc lamps, and the discussion of the problem of "The Subdivision of the Electric Light," in which was involved not merely the development of electric incandescent lamps, for which Swan and Edison were responsible, but also the idea of parallel distribution with varying load, which Edison was specially instrumental in exploring. Mr. Swinburne described in detail early difficulties in manufacturing lamps with carbon filaments, and the successive efforts to use filaments of osmium, zirconia, tantalum, etc., which were ultimately superseded by tungsten filaments, and gave rise to the electric incandescent lamp as we know it to-day.

At the conclusion of these addresses the Chairman paid a tribute to the interesting manner in which each author had dealt with his subject. To members of the Illuminating Engineering Society it was interesting to feel that they were carrying on, with modern implements, the chain of operations which the Tallow Chandlers had initiated some 600 years ago, and to hear in their historic hall such a fascinating account of their work and origin.

At the request of the Chairman, Mr. A. P. TROTTER (Past President) proposed a vote of thanks to the authors and to the Worshipful Company of Tallow Chandlers for their hospitality. He briefly recalled some of his own experiences in connection with early days of electric lighting, mentioned that in his own house in the country he was to-day dependent on the use of oil lamps and candles, and had learnt to appreciate how much could be done with such simple aid. He wished to thank the authors individually for their addresses and the Tallow Chandlers' Company for the privilege of holding a meeting under such delightful conditions.

Capt. W. J. LIBERTY, who briefly seconded the vote of thanks, said it gave him special pleasure to do so in view of his own close association with the City of London, where he had served as Public Lighting Superintendent for many years, and because of his personal interest in the history of artificial lighting.

Mr. FREDERICK PATERSON (Past Master), in replying, said that it had been a pleasure to welcome the members of the Illuminating Engineering Society, and he was glad to think that it had proved an interesting meeting. It was perhaps especially fitting that he should undertake this task, as he had been described as the father of the Tallow Chandlers' Company, and he had the additional claim on the Illuminating Engineering Society of being the father of one of their Past Presidents, Mr. C. C. Paterson. (Applause.)

Mr. C. C. PATERSON, in acknowledging the vote of thanks to the Company, said that he would like to take the opportunity of saying how much he had enjoyed all the three addresses—Mr. Monier-Williams's delightful account of the history of the Tallow Chandlers' Company, Mr. Butterfield's summary of the development of gas lighting, and Mr. Swinburne's account of early days of electric lighting. The Society had been indeed fortunate in receiving addresses from three gentlemen each of whom was an eminent expert on his subject. To the Illuminating Engineering Society there was one feature of the work of the Tallow Chandlers that was of special significance—the close attention which they devoted to the preparation of their product and their persistent efforts to define standards. In the lighting of to-day, notably in connection with public lighting, they were again engaged in efforts to achieve standardization and prepare specifications. He had been struck by the reference to "lucidiaries" as an old English term that might perhaps be revived to-day to describe lighting appliances. The term "fitting" was admittedly unsatisfactory, and the effort to replace this by "luminaire" was not entirely happy.

Mr. Paterson concluded by remarking that the present meeting had been a happy inspiration as one of the opening items in a session that followed immediately after the International Illumination Congress and after the Faraday celebrations. It was indeed "a red-letter day" in the history of the Illuminating Engineering Society, and he hoped that the fact of their having assembled to hear these addresses, ranging over the history of artificial lighting, would be suitably recorded in the annals of the Company whose hospitality the Society had been enjoying.

After Mr. Butterfield and Mr. Swinburne had briefly spoken, Mr. MONIER-WILLIAMS mentioned that the Master of the Company, who had welcomed the visitors on their arrival, had been unable, to his regret, to remain for the meeting. He wished to express his appreciation of the manner in which his address had been received, and the sympathetic manner in which Mr. Paterson had referred to the two between the Illuminating Engineering Society and the Tallow Chandlers' Company. He was glad that members of the Society had enjoyed their visit, and he could assure Mr. Paterson that the event would not pass unrecorded.

"The Tallow Chandlers' Company and Their Craft"

By Mr. R. H. MONIER-WILLIAMS
(Clerk to the Worshipful Company of Tallow Chandlers)

Address delivered before the meeting of the Illuminating Engineering Society, held in the Hall of the Worshipful Company of Tallow Chandlers, 4, Dowgate Hill, London, E.C.4, on Wednesday, November 18th, 1931.

BY way of introduction to the addresses to be delivered here to-night by two learned members of your Society on the subjects of Gas and Electric Lighting, I am asked to say something about the Tallow Chandlers' Company and the craft or trade of Candlemaking, with which in former times this Company was so intimately connected.

One of the most elementary wants of man, after he has secured food, clothing and shelter, is light during the dark hours between sunset and dawn. We are so accustomed to look upon gas, electric light and other modern methods of illumination as common-place conveniences that we are apt to forget the time—not so very long ago—when the tallow candle (now merely a curiosity) was the chief illuminant. To-night I am going to take you back some six hundred years, and trace shortly the history of the Tallow Chandlers' Company, which, for several centuries occupied such a prominent position in relation to the craft of chandlery and its allied industries.

The Tallow Chandlers' Company is one of the Livery Companies of the City of London. As, no doubt, you are aware, the precise origin of these City Guilds is difficult to trace. They are the outcome of combinations of men of the same craft, formed many centuries ago; but, in the case of our Guild, as in others, it is difficult to decide whether it was formed in the first instance for the conduct of business or prayer. Our Society was undoubtedly born long before its documentary record begins, and we have to start as borrowers from the common stock of Guild history.

The first mention of the craft appears in a will of 1233, in which the Latin word "unctuarius," meaning (probably) a grease merchant, is used. The English form of this word is first found in 1281 in the earliest "Letter Book" in the city's possession, where the word "oyntner" appears. Oynters were definitely merchants in grease who prepared for commerce the raw material supplied by the butchers.

The earliest official mention of the City Companies is contained in a statute of Edward III, dated 1363 (nearly 100 years later), which enacted that "handicraftsmen shall use but one mystery." The earliest mention of the "Tallow Chandlers' Company," as such, is thirty years later; but there is a record of certain "Masters" of the Chandlers' craft being sworn to office in 1339, and again in 1343, when we also find a memorandum of their seizure of some candles which were not up to the standard weight.

It has long been known that early in the fifteenth century the Company owned property in St. Botolph's parish, Bishopsgate Without, where they founded a fraternity of "Our Blessed Lady and St. John the Baptist"; and that towards the close of that century this church of St. Botolph had become the devotional centre of, at any rate, the yeomanry or freemen of the Company. Evidence has recently come to light which definitely identifies that locality as the headquarters of the Company long before they acquired the site of this present Hall, for we have lately learned from a title deed of other property dated in 1464 that the ancient common Hall of the Company before they migrated to Dowgate Hill adjoined the highway of Broad Street in Broad Street Ward, in the immediate vicinity of the Church of St. Botolph, Bishopsgate Without. It may be noted that that locality, being on the outskirts of the city, was specially favoured for the exercise of the craft for the reason that the feeders of the trade—the Butchers—were located there. The Butchers killed, the hides went to the Skinners, while the tallow became the raw material of the Salters and Tallow Chandlers.

As I have suggested, there is the possibility that the mystery of tallow chandlers originated in some simple religious gathering; but from the earliest times there was a natural tendency for members of the same craft or trade to meet together from time to time, to discuss matters connected with their trade and to make regulations for its government; and we know that in our case we were a *trade* organization possessing considerable powers, although not yet incorporated, in 1428. In that year King Henry VI granted to the Mayor of the City of London and to the Master and Wardens of the Tallow Chandlers' Company Letters Patent under which they were empowered to search for and destroy all bad and adulterated fats and oils. From that reference you will understand that candlemaking was not by any means the only business of chandlers, although as candlemakers they secured their fullest share of municipal attention.

The Company almost certainly had a common origin with the Salters' Company. In 1508 we find two Tallow Chandlers and one Salter appointed by the city to overlook the stock of tallow in the city, and to watch the sale of it. By the middle of the fifteenth century the Salters had obtained a clear monopoly of one great function. They were the recognized authority for the regulation of the sale of salt in the city. At a much later date we find the Tallow Chandlers advancing claims to control over the Salters in their capacity of chandlers or candlemakers.

To return to the early time of which I was just speaking, as difficulties and disputes arose respecting trade matters, it was found necessary to get greater powers. In 1456 the Tallow Chandlers' Company obtained their Grant of Arms, which is a most beautiful example of heraldic work—those of you who are interested will have an opportunity of seeing it—and in 1462 they applied for and obtained from Edward IV their Charter of Incorporation. The Yorkist King had come by his own quite recently, and tradesfolk were in favour. The moment was therefore opportune. The original Letters Patent under the Great Seal are in the Company's safe custody. Their substance is threefold: (1) the Company's internal economy, with a Master and four Wardens and power of making domestic regulations, is confirmed; (2) police powers are conferred on the Company for the correction of all persons using their trade in the Metropolis; and (3) the Company is empowered to hold land to the yearly value of ten marks.

The essence of the Charter—its great value—lay in conferring the ability to hold land. From the entry on the Patent Roll at the Guildhall we learn that the purchase of these privileges from the Crown cost the Company the very large sum of £20, one-eighth—to get a standard of comparison—of the whole price paid by them for the site of their Hall, acquired very shortly afterwards in 1476, and the latter payment was spread over ten years.

I have come to the purchase of *this* site (for it was none other) in 1476. Here—in the city—the Company soon afterwards erected their new Hall. We know from an early account book in our possession that it was in existence in 1518, and it stood for 150 years, until the Great Fire of London completely destroyed it.

In 1672 it was rebuilt, and here it is as you see it to-day. Very few of the City Companies can say the same. The great majority have pulled down and rebuilt their Halls, or altered them almost out of recognition. Fortunately (we consider) we never had the money to do so, and so we have an historical monument worthy of your attention.

You are seated now in the Hall of the Company. Upstairs is the Court-room, where for upwards of 250 years the business of the Company has been carried on by the governing body, as it is carried on to-day. It is the original room, with its seventeenth century seating arrangements. Adjoining the Hall in which you now are is the parlour or Court dining-room. It is considered to be the most beautiful of the three, and is a fine example of the Wren period. Those of you who are interested will have an opportunity, later in the evening, of inspecting the building.

I have referred to the growing importance of trade as affecting the status of the Society, and to their incorporation in 1462. Successive Kings and Queens granted and confirmed their Charters, and they later obtained from the Stuart Kings the Letters Patent and Ordinances on which the constitution of the Society is now based.

The Company is, of course, composed of the Livery or Clothing, from whom is selected its governing body (that is to say the Master, Wardens and Court of Assistants), and the Freemen, formerly known also as the Yeomanry. Most precise regulations for its management are contained in the Ordinances of Charles I, by which we are still governed. The Master and Wardens are to be elected annually, and this election is to take place on the day of the Nativity of St. John the Baptist, the Patron Saint of the Company, or within twelve days before or after that date. From sources at the Guildhall Library, and from our own records, we have succeeded in obtaining the names of all the Masters of the Company from the year 1476, and these, you may have noticed, are painted chronologically on the panels of the entrance hall.

Under several of their Charters and Letters Patent the Company were granted special powers for weighing and measuring, not only tallow and candles, but also soap, vinegar, barreled butter, salt, oil and hops, and destroying such of those articles as were bad, adulterated, or unfit for use. By a Statute of 1512, for instance, the oversight of all oils was committed to their care, thus making them to that extent the controllers of the soap-boiling industry.

In this connection there is an interesting Proclamation by the Lord Mayor in 1565 setting out that:—

> "Whereas the Chandlers sell candles at one penny and a farthing instead of at one penny the pound, and whereas this is due to the fact that Tallow in the raw is scarce and so more expensive, and whereas this scarcity of Tallow is due to the consumption of Tallow by soapmakers, therefore soapmakers shall no longer use any Tallow for their soap."

That Proclamation illustrates the control exercised by the Civic Authorities. We see evidence of this control as early as 1362, and, upon the theory that custom nearly always precedes the written record, we can suppose that for many years prior to 1362 the proportion of price between tallow and candle had been the subject of municipal attention.

The edict of 1362 ordained the sale price of tallow in the raw by butchers, the sale price of candles by chandlers, and prohibited the export of tallow by butchers.

Over a century later, in 1473, we find an edict prohibiting the use of flotice (meaning the surface scum in boiling) and grece instead of pure tallow in the making of candles, and the use of threde and flox instead of cotton for the wicks. For enforcing the regulations, search was to be made by the Wardens of the Tallow Chandlers, aided by a Mayor's officer; bad candles were to be seized, and the offenders were to be cast into prison.

The Company did not always see eye to eye with the Civic Authorities in the fixing of prices. In the following year they refused to accept the price of the year ordained by the city, and certain chandlers were imprisoned, but upon examination it was found that the butchers were to blame for selling tallow at a price higher than that fixed by the Mayor. An edict was issued against the butchers, and certain of the Butchers' Wardens were punished and the Butchers' Company was fined.

Disputes of this kind were at their height at the beginning of the next century, when there seems to have been a great scarcity of tallow in the city.

In 1515 Salters and Tallow Chandlers were bound over to sell no tallow out of the city, to make tallow only into candles to be sold in the city, and to give information against each other in case of default. A year later Wardens of the Tallow Chandlers were committed to Newgate Prison for disobedience in selling candles at a price above that fixed by the city. Again the butchers were blamed. Three years later an Order was issued to the effect that no tallow should be sold out of the city, or to anyone but the Tallow Chandlers and Candlemakers; but, after a powerful demonstration by the butchers *en masse*, fear lest they refuse to supply London with meat seems to have made the city hold their hand, and the struggle died down.

The Company were for a period responsible for the lighting (if such it can be called) of part of the city of London in conjunction with the Horners' and Tinplate Workers' Companies, the Tallow Chandlers' Company supplying the candles and the Horners' and Tinplate Workers' Companies the lanterns in which they were burnt. As a means of illumination, these lanterns, which were few and far between, were sadly defective, but the monopoly had been enjoyed so long that in 1694 a vigorous protest was lodged by the Company against a licence granted in that year to certain persons "concerned and interested in glass-lights, commonly called and known by the name of convex lights," for the sole supply of the public lights in all public places in the city for a period of 21 years. The petition of the

Company to the Lord Mayor, Aldermen and Commons of the city of London in Common Council recited an act of the Common Council of the 3rd October, 1599, whereby every householder from the 1st of October to the 1st of March in every year for ever should cause a substantial lanthorn and a candle of Eight in the Pound to be hung without his doors. It went on to complain that "notwithstanding the said Act certain untrue men, who are not capable of serving any office in any Company, nor office of Trust within the City, neither chargeable towards the support of the grandure and government of the same, have set up and do continue in the streets of this City and Liberties thereof a great number of Convex-Lamps and other Lucidaries, in opposition to and derogation of the said Act and to the manifest injury of this and other Companies in their lawful trades." The petition further alleged that the said lamps or lucidaries were merely novel, and that should they be encouraged they would cause many more such intrudings upon other Arts and Mysteries, whereby the Labour and Industry of many thousands might be lost and their families impoverished. It was maintained that if the continuance of these lamps be suffered, they would hinder the making and selling of seventeen dozen of candles to every lamp set up and used in the City and Liberties every year, and that other trades, such as the Horners, in making Leaves for Lanthorns for burning candles in, tinmen, and spinners of cotton, "whereof the twentieth part is not, nor cannot be used in lamps, which is and must be used in candles," would be deprived of their profits, and many hundreds of persons (that live solely by those trades) of their maintenances and Livelyhood.

In spite of this protest, the licence was not revoked, and no doubt there was some improvement in the lighting of the city during the next twenty-one years, but whether on account of continued opposition on the part of the Tallow Chandlers' Company, or for other reasons, it was not renewed in 1716, and many parts of the city were again without even the feeble glimmer of the convex-lamp. In that year every householder whose house fronted on any street or lane, and was rated at £10 or over, was required to hang out one or more lanthorns with sufficient wick-candles between six and eleven o'clock every dark night from the 29th September to the 25th March. This provision proved quite inadequate, because most of the inhabitants were rated below £10, and the period during which the streets were to be thus lighted was not long enough, so that the peaceful citizens of London were exposed to street robberies and housebreaking.

Until 1736 this form of lighting was carried out by contract, but robberies had increased to such an extent by that date that powers were taken by Parliament for lighting the streets in a more effectual manner, and the number of lamps were considerably increased, but even then were not nearly sufficient.

In 1762 the Westminster Paving and Lighting Act was passed, and the days of the lamp-lighters began with the tin vessel containing oil.

A few word about our muniments. With one important exception, we have none prior to the Reformation, but we nevertheless possess in our strong room a better collection of records for some 450 years of our history than most of the City companies, and we are most fortunate in having our early Charters intact. The Company, of course, suffered severely by the Great Fire, which not only consumed their Hall, but several other houses belonging to them. Fortunately, owing to the energy of the then Master, the Charters, title deeds, books and other archives of the Company were all removed from the Hall before it was burned, and thus saved from destruction. Among those treasures was the original Grant of Arms of 1456, to which I have referred. It was made by John Smert, Garter King-of-Arms to John Priour, John Thurlow, William Blakman and Richard Greencroft, sworn Wardens or Keepers, and several other notable men of the trade and of the Company of Tallow Chandlers of the City of London, on behalf of and in the name of their whole confraternity. It is not only chronologically the first of the Company's muniments, but artistically the finest. In it Garter recites the use of arms by trade guilds for their common seal, for display at feasts and assemblies, at Church for the great honour and adornment of the sacred spot where the divine service is performed, in their Halls, and at tournaments. He is informed, he tells us, that the Company of Tallow Chandlers in London is a "mistery," a member of the City, with Wardens sworn to duty, and other officers authorized to make ordinances for the governance of the Craft, as distinct from other crafts. The Coat-of-Arms, depicting three doves, and the Crest, depicting the head of John the Baptist on a charger, doubtless have reference to the Patron Saint of the Company—"and John bare record saying: 'I saw the Spirit descending from Heaven like a dove and it abode with him.'" (John, 1, 32.)

In conclusion, I must mention the Grant of Supporters by the Great Camden in 1602. This is fortunately preserved in the Company's strong room, but it is far less remarkable for artistic beauty than the original Grant of Arms which you see here. Camden, however, pays one of the happiest compliments ever paid by herald, when he assigns the Company "Supporters being angelles crowned with starres in token of light whereof their mistery is a beautyfull imitacion." You will see the Arms, with the supporters, over the door. Although comparatively modern, they are beautifully carved, and are a correct representation of the Arms of the Company with the proper heraldic colours.

I have tried to give you a brief review of the constitution and growth of the Company and its trade activities. So far as the latter are concerned, they are now matters of history. The divorce from trade which has taken place in nearly all the City Companies was gradual in our case as in others, but, in course of time, we have lost practically all association with our trade. To-day the functions of the Company consist of managing their properties and administering their modest funds for charitable purposes. These functions are themselves several centuries old, and they are being faithfully exercised to-day.

I will now make way for Mr. W. J. A. Butterfield, M.A., who is going to tell us about the introduction of gas and the historical development of gas lighting.

(At the conclusion of the meeting Mr. Monier-Williams pointed out to those present various features of interest in the hall, to which allusion had been made in his address, and an opportunity was also afforded to visitors to examine some of the other rooms in the building, which contained numerous objects of historic interest.)

The Historical Development of Gas Lighting

BY W. J. A. BUTTERFIELD, M.A., M.Inst. Gas E.

Address delivered at the Meeting of the Illuminating Engineering Society held in the Hall of the Worshipful Company of Tallow Chandlers (4, Dowgate Hill, London, E.C.4), at 6-30 p.m., on Wednesday, November 18th, 1931.

ONE hundred and twelve years have passed since T. S. Peckston, of the staff of the Gas Light and Coke Company, in his book on the "Theory and Practice of Gas Lighting," asked the question, "How are we to produce the greatest quantity of light at the least expense?" He went on to show that the answer to his question would be found in the proper application of coal gas. The historical development of gas lighting follows mainly from this answer to this question having remained incontestably true from the very beginnings of public gas supply (one hundred and twenty years ago) right up to the present time. The claims made first by one, then by another, and by still another rival illuminant, have not succeeded in wresting from coal gas the pride of place which it has held for over a century.

In the early part of the nineteenth century the illuminants with which coal gas competed were tallow, wax or spermaceti candles, and lamps using whale-oil or other animal or vegetable oil. Even primitive types of gas burner enabled coal gas to show greater economy and efficiency than these illuminants, while at the same time dispensing with the necessity for periodical attention, e.g., the snuffing or trimming of wicks, replacement of spent candles, or replenishment of exhausted oil reservoirs. While gas at that time could scarcely claim to be a rival of the candle-stick and the hand-lamp in respect of portability, it succeeded in demonstrating that portability was not a *sine qua non* in the lighting of any interiors. Portability had previously been essential only because general illumination from fixed points adequate for all requirements could not be attained until gas lighting was introduced. In this respect gas is the pioneer of modern artificial lighting.

Passing by a number of earlier demonstrations that gas could be obtained from coal and that it burned with a highly luminous flame, it is common knowledge that the foundations of modern gas lighting and gas supply were laid when William Murdock lit up his house at Redruth with gas in 1792, and the Soho factory at Birmingham in 1802. Le Bon had made similar demonstrations of gas lighting in Paris in 1801 and 1802, and under the auspices of F. A. Winsor part of Pall Mall was lighted by gas on January 28th, 1807. Public gas supply, however, came into being with the formation of the Gas Light and Coke Company, which was granted a Royal Charter in April, 1812. Thenceforth, wherever gas mains were laid in the streets, other methods of lighting were superseded by gas, which for half a century had no rival worthy of the name.

About the middle of last century, however, mineral oil was introduced as a substitute for animal or vegetable oil in lamps. This change gave the oil lamp a brilliancy which had previously been unattainable from any illuminant except gas. Gas responded to the challenge by taking advantage of the efforts of many inventors of improvements in gas burners. These improvements included the application of non-conducting tips and governors or regulators, while for the larger units regenerative devices were adopted. There was a steady advance in the conservation of the heat of the gas flame, and therewith a marked growth in its illuminating power and in the efficiency of gas lighting. Gas thereby was put on a par with mineral oil in respect of economy as an illuminant. Moreover, the fire risks arising from the ready inflammability and great mobility of the bulk of the lamp oil of that period weighed strongly against its use wherever coal gas was available. There are still many people who can remember, however, the intensive struggle between gas and kerosene for the interior lighting of the smaller houses in our towns. They can recall the manner in which gas, aided by the prepayment meter as a tireless salesman unhampered by the provisions of Shop Hours Acts, eventually triumphed over the oil lamp, which is now relegated to rural areas which have not yet been favoured with a public gas supply.

The survival of the oil lamp and candles in many rural areas is due primarily to the fact that no better illuminant is yet available in them. The more densely populated districts were the first to be traversed by gas mains, and the distributing systems of gas undertakings have only gradually been extended to outlying areas which promised a satisfactory return from the sales of gas. The charges for reinstatement of road-surfacings when mains or cables are laid under the public highways increase distributing costs enormously, especially since reinforced concrete foundations have become common on main roads. Relief is afforded when wayleaves and other facilities for transmission across country are obtainable at nominal cost. In this respect there is now a useful precedent (in the electricity grid) for power being granted for the high-pressure transmission of gas through mains laid under fields and downs, where reinstatement charges would be trifling, and traffic effects non-existent. As soon as such powers have been granted one may forecast that the next stage in the historical development of gas lighting will be its rapid adoption over a far wider area than hitherto.

Throughout the history of gas lighting, failures of gas supply, either general or local, have been practically unknown, unless flood, earthquake, or other "act of God" has intervened. This record of trustworthiness of gas lighting has proved it to be eminently suitable for adoption for the major part of the lighting where the public safety may be endangered by any failure, as for instance in hospitals, assembly rooms, places of entertainment and crowded streets.

The candle and oil lamp have, however, another association which is of greater scientific interest. When burning, each of them is a miniature gas works combined with a gas burner, as Peckston pointed out in 1819, and gas may therefore be regarded as the lineal descendant of the illuminants for whose control and protection the Guilds of Tallow Chandlers and Wax Chandlers were formed. Gas may be accepted as the modern counterpart of the candle, since both are flame illuminants. On this account, the Worshipful Company of Tallow Chandlers, in whose hall this address is given,

should take a special interest in the developments of gas lighting.

The early 'eighties witnessed great developments in artificial lighting. The electric bulb lamp was introduced only a year or two earlier than the gas mantle, as perfected by Baron Auer von Welsbach in or shortly before the year 1886. Just as a few decades earlier, the supply of cheap mineral oil had raised the oil lamp to the position of a formidable competitor with gas as an illuminant, so did the electric bulb start a new era of competition with gas lighting. There was one marked difference, however, in the character of the competition. Whereas kerosene challenged the supremacy of gas in the smaller houses, on the score of cheapness, the electric bulb appealed to the well-to-do mainly by reason of the convenience of the switch. Whether history will repeat itself, and gas improve its position as a lighting agent in this country, remains to be seen. There can, however, be no question that the competition of the electric bulb has already greatly stimulated advances in gas lighting, which has developed in an amazing manner since the early 'eighties. The principal stages in this development deserve notice.

The introduction of the gas mantle provoked a fuller study of the mechanism of flame. It had already been realized that the luminosity of the ordinary gas flame depended on high temperature in the zone in which the liberated particles of carbon were raised to incandescence. Further, it was known that at flame-temperatures the radiation of light increased as the fourth power of the temperature, and the importance of raising and conserving the flame temperature was appreciated in the design of burners prior to the advent of the mantle. The latter called for a revolution in burner design, because if a mantle were brought into contact with a luminous gas flame, smoke or soot would be liberated through the cooling of the carbon particles which are liberated in one zone of that flame. It became necessary to apply the type of gas burner which is named after its inventor (Professor Robert) Bunsen, in which an internal air supply renders the flame non-luminous and free from smokiness even when in contact with a solid. It was essential, however, for the highest incandescence of the mantle that it should be shaped to fit the outer zone of maximum temperature of the bunsen flame, or conversely that the flame should be modified to fit the mantle.

The early incandescent gas burners gave so great an advance in light over that obtainable previously for the same gas consumption that faults, which are now palpable, passed uncorrected for some years. The greatest of all the defects of the early mantle burners, viz., that the greater proportion of the light was radiated above the horizontal plane, remained unremedied for at least ten years. It was then found that with adequate gas pressure a well-designed bunsen burner would function properly with its mouth directed downwards, and that consequently the flame could be used to heat to incandescence an inverted mantle of bee-hive shape suspended from lugs on the inverted burner. The distribution of light was thus reversed; the major part was radiated below the horizontal plane, unobstructed by parts of burner or fitting. The inverted burner, moreover, lent itself to better conservation of the heat of the flame, and therewith the attainment of more intense incandescence of the mantle. The development of the inverted gas burner synchronized approximately with the supersession of the carbon by the metallic filament and gasfilled electric bulbs, and thus gas lighting was enabled to retain its position.

The inverted gas burner is susceptible of great adaptability to environment. Over a solid angle of more than 90°, light is radiated downwards direct from the extended surface of the mantle, without the interposition of a glass envelope. It is the relatively large area of the mantle, and the absence of refraction of the rays by the glass of an envelope or bulb, that make modern gaslight so comfortable a source for interior lighting, especially of small rooms, where lights of high surface brilliancy encased in clear glass may become very trying to the eye.

The introduction of the inverted gas burner was followed by the application to it of regenerative or recuperative devices for raising the temperature of the flame, and, in still greater ratio, the lighting efficiency of the burners. Of more limited application has been the supply of gas at pressures much above the normal to burners with elongated mantles, which singly or grouped in twos or threes give light sources of 600 to 4,500 candle-power. Among the best examples of lighting by high-pressure gas may be mentioned the lamp standards in Whitehall, Westminster, as regards outdoor use; and, as regards interiors, the lamps by which the museum galleries of the Council House at Birmingham are so effectively illuminated.

In the early years of gas supply, the public lamps were converted from oil to gas in practically every street in which gas mains were laid. There are many streets which have been continuously lighted by gas for more than one hundred years. Public lighting is being extended in every direction to meet the conditions of faster traffic, and one of the most noteworthy developments in connection therewith is the introduction of gas lamps suspended centrally over the carriageway.

As regards the lighting of interiors, it is not only by reason of its low cost that gas lighting has survived varied and keen competition. In relation to the illumination they afforded, the early gas burners had a very great heating effect, but the development of the mantle and the inverted burner has effected so great a reduction that the heat from the gas lights needed in any room is now no more than is serviceable in combating the chilliness which is felt more or less in this country on at least 300 evenings in the year. On all occasions the currents of air induced by gas lights promote ventilation.

The scientific grounds for the satisfaction they obtain from gas lighting may not be known to many of its votaries, but no history of gas lighting can pretend to be complete which does not record the fact that it has won and retained the confidence of millions of the inhabitants of great Britain. It may be that domestic habits, or the economic or climatic conditions here, have been peculiarly favourable to its adoption, though it must also be borne in mind that technical progress in gas lighting has been more rapid here than in almost any other country.

The earliest gas burners gave a light equal to about 2 candles per cubic foot of gas consumed. The gas of that period would have had a considerably higher calorific value than any of the gas distributed at the present time. Probably 1,000 cubic feet then would have been equivalent

to 7 therms, whereas 1,000 cubic feet in London north of the Thames are now equivalent to 5 therms. The light obtainable through modern gas lamps from 1 therm is about thirty times that obtained in the early days of gas lighting. These figures confirm the foregoing statement as to the great reduction in the heating effect of gas lighting effected by modern improvements. The whale-oil lamps which gas superseded gave only about two-thirds of the light from gas burners of that date per unit of heat in the respective fuels, and as the oil cost from 5s. to 10s. a gallon the oil consumption of the lamps was kept as low as possible in order to reduce the outlay on lighting. It is not, therefore, surprising to read in reports of the period that the "parish" or street gas lamps of 1815 gave twelve times as much light as the oil lamps which they displaced.

The eye is a wonderful organ from every standpoint, but not least in regard to its powers of accommodation to varying degrees of illumination. These range from full sunlight to that of the miner's lamp, but in any discussion of the adaptability of the eye to such extremes it must be borne in mind that it may be temporarily and even permanently damaged by either too high or too low illumination. Everything depends on the degree of illumination being appropriate to the immediate requirements of visibility. Thus, a ploughman, or sportsman, viewing distant objects on a background of non-reflecting dark soil, grass or trees, finds full sunlight does not over-illuminate them, and should he desire to follow the same pursuits after dark, searchlights or floodlighting could not be too powerful. But if close vision of detail in black and white, as reading print on glossy art paper, is attempted in full sunlight, the eye suffers at once from over-illumination and reflection, and the shade of tree or roof is sought for its protection. We cannot look at the sun in a cloudless sky at noon with impunity; neither can we gaze for long at snow when the sun shines brightly on it. But even full sunlight is not too strong for us if we are looking at a matt dark-coloured surface.

These facts reveal to us the principles which we should observe when we have to apply artificial lighting to our needs. The illumination must be adapted to requirements; we do not want anything akin to a searchlight directed on white-tiled walls, white tablecloths, or even the page we are reading, whereas "black" needlework demands strong lighting. The source of light must not ordinarily come within the line of vision, and if it is impossible at times to avoid this, the source must be of relatively large area and generally of such a character that its light is well diffused. Concentrated rays of light must not be directed at or reflected into the eye if it is desired to preserve the sight unimpaired.

Gas lighting fulfils the conditions which the eye calls for in an artificial illuminant. Eyes suffered through inadequate lighting of work in the days of the candle, and this suffering is perpetuated in many coal mines, where miner's nystagmus or blindness is a painful and costly sequel to the poor lighting. On the other hand, many instances can be given of damaged eyesight due to too great brilliancy of sources of light. Historically, gas has been proved to afford a *via media;* the intensity and character of the more usual forms of gas lights render them safe sources of artificial illumination. It seems desirable to stress this point, because gas lighting has suffered in prestige through the retention of burners and appliances which should long before have been scrapped. It will be found that when complaints have been made of gas lighting, burners and fittings have invariably been worn-out and obsolete. History reveals that there is an unfortunate tendency to forget that gas appliances, like all else, are subject to the ravages of time and use. Under the heading of "wear and tear" proper allowance should be made for their ultimate renewal. If this were done generally—in domestic, industrial and public lighting—gas would continue to fulfil all requirements as an illuminant.

Since comparatively early days attempts have been made to control gas lights from a distance. A duplication of pipes, one set for the supply of burners and one for pilot-jets, was not uncommon in public buildings fifty or more years ago, and served its purpose tolerably well. It was not so satisfactory with incandescent burners, owing to lighting-back of the bunsen burners before the supply pipe had been wholly cleared of air. To avoid this, means of operating from a distance a tap or valve close to the burner were sought, and three of such means have given reasonably satisfactory service. One is the Sugg distance control, which solved the problem so far as public lamps and the lighting of factories and large halls were concerned. For dwellings and offices there are two forms of switches, one operated pneumatically and the other by a wire on the Bowden principle. The author, after several years' use of the pneumatic switch, has found it entirely trustworthy provided it is operated at least once in 24 hours. If left unused for some days this switch may fail through the piston sticking to the wall of the cylinder, but this does not occur when the pneumatic switch is in regular use. The later form of wire-operated switch is more positive in its action, but is more troublesome to install. Both switches, however, can be fixed in rooms already decorated, with practically no interference with the decorations or damage to walls. The leads are unobtrusive and introduce no fire-risks.

All these gas switches, however, require a by-pass to be kept alight, and while the faint light therefrom serves the purpose of the night-light of our childhood, there are situations where an alternative method of igniting the gas would be preferable. It is not improbable that one of the next stages in the history of gas lighting will depend on the development of gas burners which are self-lighting without a by-pass.

Further information on the historical development of lighting may be gathered from text-books, specimens of a few of the earliest of which, and of pamphlets of historical interest, are exhibited to-night, viz.:—

"Account of the qualities and Uses of Coal Tar" (Earl of Dundonald), 1785.

"A Practical Treatise on Gas Light" (with Ackermann plates), by Frederick Accum, second edition, 1815.

"The Theory and Practice of Gas Lighting," by T. S. Peckston, 1819.

"The Process of Manufacturing Coal Gas," by Frederick Accum, 1819.

"A Practical Treatise on Coal, Petroleum and other Distilled Oils," by Abraham Gesner, 1861.

"1812 — 1912. Centenary Commemoration Volume of the Gas Light and Coke Company," 1912.

"National Gas Congress and Exhibition, 1913." Guide, with Historical Appendix.

The Early History of the Electric Light

BY J. SWINBURNE, F.R.S.

Address delivered at the Meeting of the Illuminating Engineering Society held in the Hall of the Worshipful Company of Tallow Chandlers (4, Dowgate Hill, London, E.C.4), at 6-30 p.m., on Wednesday, November 18th, 1931.

THERE was a curious outbreak of electrical invention from eighty to ninety years ago, when various kinds of electric lamps were proposed, and even electric traction was considered. The fundamental obstacle, however, was the expense of primary batteries, as the dynamo was not then known.

Among the early workers was Staite, who made an incandescent lamp with a wire conductor; and there were several designs for arc lamps of various kinds, using gas-retort carbon, which was irregular, and very expensive, owing to the difficulty in working it.

In the 'sixties and 'seventies the dynamo gradually became commercial, and a great impulse was given by Gramme in the early 'seventies. The early dynamos were nearly always designed for arc lighting, each machine giving about 60 volts and some ten amperes, and running one arc.

It was realized that electric lighting with a dynamo for each light was not practical, and the great problem of the day was the "Subdivision of the Electric Light," an expression that has so little meaning to modern engineers that they cannot understand what the real problem was.

It is very difficult to get one's ideas back to those times. We must imagine a lot of enthusiastic inventors with very little knowledge and almost no apparatus. As to knowledge, there were technical schools, but they were not turning out streams of highly educated young electricians. There were no text-books as we know them. There was Maxwell, which was too mathematical for anybody but a trained mathematician to follow, and even then the information was not in a useful form. There were text-books of physics, but the electricity chapters were devoted to static electricity, with dolls' heads with hair on end, and descriptions of batteries for "voltaic electricity," and there was no practical knowledge about electromagnets. There were no voltmeters and ampere meters as we know them.

Dynamo design was a mystery, and the only dynamos on the market were series-wound arc machines. There were some machines separately excited, such as the Siemens alternator, and the manifold circuit machines used for the Jablochkoff lamp.

The desideratum being the sub-division of the electric light, we may look on the series arc-lighting of Brush in America and the Jablochkoff candle and its system as solutions. Very little later Crompton was going ahead in this country with arc lamps in series on Crompton Burgin machines.

Many years earlier, before the advent of commercial dynamos, Swan had experimented on carbon incandescent lamps. As a young man, Staites' work had stimulated his enthusiasm, but as he realized that batteries were not a practical source of power he had shelved his experiments.

He had tried filaments of all sorts of likely materials, especially various kinds of papers, and had seen something of the promised land; but there were no good ways of making a vacuum, and the filaments did not last.

The advent of the dynamo and the arc lamp set Swan to work again. Crookes had made his radiometer, and had used the Sprengel pump, which gave what was called a high vacuum in those days. Swan got into touch with C. H. Stearn, who was then an amateur experimenter interested in Crookes's work, and C. H. Gimingham, a skilled glassblower and good experimenter, who was Crookes's assistant.

The first promising lamps made by Swan had thin sticks of carbon—probably 1-mm. carbons made by Carré, of Paris, about that time. They ran long enough to show that Swan was on the right track.

The difficulties now were the numerous details, which had to be worked out. The idea of using a number of small lamps in parallel on a pressure then considered very high, such as 100 volts, was, I think for the first time explained with perfect clearness by Lane-Fox. After the publication of the Lane-Fox patent there was still much to do in "Subdividing the Electric Light," the two main problems being to make small 100-volt lamps and to produce dynamos which gave constant pressure on varying load.

Swan does not appear to have worried about the dynamos difficulty; he concentrated on his lamp. He could always get some sort of constancy of pressure by using the Siemens alternate-current dynamo, which was separately excited.

After working over his paper experiments again, he found he got a much better result by partly dissolving and precipitating cellulose, using parchment paper as sold for covering jam-pots. He soon found knitting cotton immersed in sulphuric acid and washed gave best results. It made a material looking like cat-gut. This was drawn through dies to cut it to uniform diameter; and then had muslin thickening, which was parchmentized to make thickened ends. The carbon had to be cold enough to be gripped at the ends without burning the clips.

Swan prepared the carbons and sent them to Stearn to be exhausted. These lamps took about four watts per candle, and cost 25s. each. Now we can buy incandescent lamps for sixpence. The filaments were held in carbon moulds, which allowed for shrinking, and were embedded in carbon in saggars and heated in a pottery furnace at first, and later in gas furnaces. The filaments were mounted in little steel conical clips, which were mounted on long clips in the stem of the lamp. The early Swan lamps had long stems, as this was considered necessary to get rid of the heat.

Trouble also arose from occluded gas in the filament, and especially in the thickened end. Swan got most of this out, and cleaned the glass too by running the lamps towards the end of exhaustion.

During this time Edison was also at work in America. He was working at a platinum lamp. But Edison and Swan approached the subject from two different standpoints. Swan set to work to make a small light unit. The idea of parallel distribution was known; but most engineers were working at arc-lamps and series dynamos. Edison, on the other hand, was working at the whole problem, and thought he had invented parallel distribution with varying load. When Swan published his good results with carbon, Edison, having probably heard of Swan's results, took out a distribution patent, the key being a high-resistance filament of carbon suitable for being run in parallel on a 100-volt circuit. There was nothing in this specification helpful as to making an incandescent lamp.

Swan went on with his work, and was soon making 40-60 volt lamps commercially. This pressure was probably chosen to fit the alternators which, like the direct current machines, were designed for arc lighting.

Towards the end of 1881 the shunt-wound machine began to come on the market, and electric lighting with incandescent lamps began to be fashionable in country houses. Meantime the arc-lamp had gone ahead too, and there were large numbers coming into use, in series on high-tension circuits fed by series machines.

In 1881 Edison, who, as already explained, was tackling the whole problem of parallel distribution from the dynamo to the lamps, put down a central station in Pearl Street, New York. Large direct-current drum-armature machines were used, direct driven by what were then called high-speed engines; and mains were put down to supply the surrounding district at 100 volts. As might be expected, with the knowledge of these days, the system gave a lot of trouble; but nothing discouraged Edison. Somewhat later he put down a supply system on the same lines at Holborn.

The arc-lamp was gradually being improved, and its use extended; and the uses of both gradually increased. The arc lamp was used chiefly for railway stations, streets and large buildings: the incandescent for country houses, theatres, hotels and public buildings. Crompton astonished the world by lighting the Vienna Opera House, not to speak of the Law Courts; and much of the development of electrical engineering is due to his tremendous driving force.

The next big improvement in the incandescent lamp was the introduction of homogeneous cellulose by Weston. He used nitrocellulose reduced by ammonium sulphide or ferrous chloride. Swan, however, invented a process by which the pyroxylin was dissolved and squirted into a setting medium, producing a uniform thread of homogeneous material. This was in 1884 or 1885.

Town lighting was difficult at first, as 100 volts is too low a pressure except for very small areas. On the three-wire system 200 volts could be used, but even that made the mains too large. At first it was not possible to get a large number of consumers close together, so the area per 1,000 lamps was large. An early solution was the house-to-house transformer system. Gaulard and Gibbs had introduced a transformer system with the primaries in series and a fixed load on the secondaries; but their ideas were crude, and the system, tried on the Underground, was not a success.

In 1885 the use of transformers with their primaries in parallel and approximately constant-pressure secondaries came into use. This system was developed very quickly in different countries, Ferranti doing good work here.

The development of electric lighting since the early 'eighties has largely been the perfection of systems of distribution. The problems of distribution, as they involve transforming, cable-making, switchgear, and, finally, dynamo and engine and power-house design, are too large for discussion in this paper.

There were many advances in lamps too. The arc developed along three lines. In the enclosed arc the great cost of the consumption of the carbons was very much reduced.

Arcs were soon made so that they would run on constant-pressure circuits. An arc-lamp itself needs lower pressure as its current increases, so on a constant-pressure circuit it needs a resistance in series, so that the volts available on the arc fall if the current increases. This is, of course, a wasteful arrangement.

The next important improvement was the flame arc. In this the carbons were impregnated with salts, which enlarged the luminous arc and coloured it pink or red, so that it gave more light, and that of a very much pleasanter tint.

In incandescent lamps the great advance has been the reintroduction of metal filaments. Edison used platinum, like the earlier workers, but it melts too easily.

Aur von Welsbach made osmium filaments. These worked at a high enough temperature to give a high efficiency; but osmium conducts too well to enable the lampmaker to use thin enough wires to get small powers on high pressures. The osmium lamp was chiefly useful on motor-cars.

The next solution was the Nernst lamp. Nernst used a tiny rod of zirconia, or similar oxide, at a temperature at which it conducted. This was used in the open air, and though there was loss by convection the temperature was so high that an efficiency of about two candles per watt was obtained. The little rod did not conduct when cold, so a little heater was used to start it, the heater being cut out as soon as the lamp lighted. This arrangement was complicated.

The next step was the use of tantalum. This was a wonderful advance, because tantalum is a most intractable metal. All the same, von Bolton, of Siemens & Halske, solved the problem.

The next step was the use of tungsten. Welsbach had squirted osmium as a powder, and then sintered it. The same process was applied to tungsten. The great step was, however, made in the Research Department of the General Electric of America. They succeeded in drawing tungsten into exceedingly fine wire, and gave us the tungsten lamp of to-day.

The next big improvement came from the same laboratory. The tungsten filament in vacuo is corroded by what is known as gas washing. Langmuir realized that the use of a suitable inert gas, like argon, at a reasonable pressure stopped the gas washing; but the loss by convection then became serious. By using a thick wire, or a thin one closely coiled, Langmuir found the convection could be so reduced that high temperature could be used without undue convection loss, and he brought out the gasfilled lamp which, in its larger sizes, works at an efficiency of two candles per watt.

This lamp has almost ousted the arc-lamp for house and street lighting.

What the next great step will be I do not know. Most likely it will be in the direction of utilizing some form of electron discharge.

Sheffield Illumination Society

On November 4th, members of the above Society were entertained by Mr. G. H. Jones, of the General Electric Co. Ltd., who gave a popular lecture on "The Talkies." Mr. Jones explained how the cinematographic projector worked, and how synchronized sound was produced. His points were illustrated with lantern slides and apparatus, a practical demonstration being given of the projector and photo-electric cell.

A visit to the Fire Station was made on November 9th, where Superintendent Breaks, of the Sheffield Fire Brigade, introduced members and friends to modern fire-fighting methods. The brigade gave a striking display, showing the use of the engines and life-saving apparatus. An exciting diversion was caused by the brigade receiving a call to a house on fire, and the party had a real demonstration of the efficiency of the modern fireman!

Floodlighting for the International Illumination Congress: The Lessons to be learned from it

By PERCY GOOD

(*Deputy Director B.E.S.A.; Chairman, London Committee of the International Illumination Congress.*)

(A collection of photographs and a number of lantern slides and some models were shown.)

(*Introduction to a discussion at the Meeting of the Illuminating Engineering Society held at the House of the Royal Society of Arts* (18, *John Street, Adelphi, London, W.C.*), *at 6-30 p.m., on Friday, October 30th*, 1931.)

WHEN the Council of the Illuminating Engineering Society decided that an evening at an early date might profitably be devoted to a discussion on floodlighting, whilst the memory of the lighting of the various public buildings and gardens in connection with the International Illumination Congress and Faraday Centenary Celebrations was reasonably fresh in everyone's mind, it would normally be expected that they would invite an expert on the subject to prepare a paper as a means of creating the discussion. Presumably the choice fell on me because I happened to have been in close touch with the work of making the arrangements. I am not employed by either the lighting or its associated industries, nor am I an expert, and speak therefore from an outside point of view, as an amateur. My only contact with floodlighting has been the very great privilege and pleasure of having been associated with a large team of experts in an effort to show both our foreign visitors and Londoners themselves that London can show itself to advantage at a relatively small cost.

The public appreciation of the result of the floodlighting of comparatively few of our public buildings in London was so spontaneous—almost overwhelmingly spontaneous—that those who were generous enough to undertake the work free of charge, as well as the authorities who made it possible, must feel satisfied with the result of their public-spirited action.

Whilst I do not want to keep you too long from the technical discussion, I believe you will agree with me that this is the appropriate opportunity to place on record an appreciation of the services rendered by those concerned.

The scheme started with an attempt to secure the floodlighting of four public buildings, as part of a plan to show London effectively to our foreign visitors, and I think that it would have been stillborn had not the Lighting Service Bureau of the E.L.M.A. during several years previously laid a very substantial foundation, and Mr. Jones, the manager of the Bureau, very skilfully handled the earliest negotiations with his members: and in these matters, if the start is right, more than half the battle is won.

I should also like to record how, when almost a blank seemed to face the proposals, Mr. Hughes of Siemens Bros. stepped in, making the first offer on behalf of his company and Holophane Ltd. This was followed by offers from the Edison Swan Company and the General Electric Company, and eventually a number of others joined in. Then came the question of the co-operation of the gas interests. They were asked to take part in floodlighting, a field previously unexplored by them, and fortunately the Governor and Directors of the Gas Light and Coke Company were found willing to go to considerable expense in experiments to see if they could assist. The time was short, and only by great efforts, on which their research staff, under the direction of Mr. Clark, are to be complimented, were they ready to participate.

The Office of Works has charge of a very large number of public buildings. Our approach to the Department was in connection with some of the most important of these, and we had from the start the unfailing support of the First Commissioner of Works and the staff. The advice and guidance given by Mr. Hubert Baines, the Chief Engineer, and the officers of his Division, were of the greatest service. Mr. Macintyre, the Second Engineer, is well known for his association with the Illuminating Engineering Society: he was on the Council of the Congress and on the London Committee, and was heart and soul with us. Mr. Baines nominated Mr. Ames to act as the liaison between the London Committee and his Department, and it is not possible to overstate the extent to which his help and guidance have been appreciated by those who have carried out the work.

I must add that all who have thus made contact with the Office of Works realize that H.M. Government is to be congratulated on having a staff with such a high ideal of public service, and such a sympathetic understanding of the importance of the national buildings under their charge.

Then behind the scenes, so to speak, were people, some in high places, some lower down the scale, who were available at short notice when difficulties loomed in front of us, and for whose guidance, advice and help much thanks is due.

Finally, as soon as the scheme was launched, the London Committee found themselves surrounded by a spirit of co-operation which, in my experience (and in a secretarial capacity, I am connected with over 500 committees doing co-operative work, so that I am qualified to express an opinion), has never been equalled. This co-operative spirit grew, and those responsible for the organization of the celebrations throughout the country found the spirit contagious, and soon met with a very satisfactory response. I cannot give the exact number of installations, but it will be seen from the illustration (slide No. 1) that there were a great many, and in all cases they created much enthusiasm.

Apart from the technical value of the Congress, has the effort been worth the trouble and expense? I would like you to answer that. I need only say the foreign delegates to the Congress were, I know, not only satisfied, but most of them have taken back a much deeper appreciation of London and of this country than they had before. The press in all countries gave the London illuminations considerable publicity, and a large number of our own people learned a good deal about their capital city, and have discovered that there is an enormous field open for the use of light which they had not hitherto appreciated. The following quotation from the *New York Evening Post*, sent me by the Travel Association, who deserve much credit for the increased attention which the attractions of Great Britain secure from the press in America, will indicate something of the views held abroad:—

> LONDON, October 9th. How Londoners love their city! . . . And with what reason!
>
> The illumination of notable buildings here, which began September 1st as an adjunct to the meeting of the International Illumination Congress, has done more to reveal London's beauty to native and visitor than any other event in a generation. Indeed, one

should rather say that London hasn't ever before been so revealed, so intimately, lovingly and proudly outlined to men's eyes. Unnoticed architectural beauties of line, of proportion, of colour, of detail are being startlingly, sometimes selfishly, stressed. The artifice of lighting gives London a fine reassurance of her vested quality of the superb. Old wonders are made new among the acres of drab streets which dwellers here too often believe set the tone and character of this distinguished and luxurious capital.

The display erupted at a time of great uncertainty and doubt, when critical decisions were being made to avoid what in many minds presaged national ruin. Britain's pride was going the way of her trade balance. The 'falling house that never falls' was shaken to her foundations. . . . Whatever fortune is in store for London, who can say what courage and pride were distilled among her citizens when they gathered literally in millions to see old glories made young by the unnatural but compelling magic of a spectacular mechanical *tour de force*? . . . .

Moving through the throngs one sensed an almost articulate sentiment of reassurance bordering on relief. The splendour of London has been endangered before. But it has persisted. These nights it is visible, tangible, in the resourceful Portland stone of which the Metropolis is built, the stone which ages so richly into black and white, but which survives so long. Whatever happens to London, London Bridge is not falling down. The glare of remorseless candle-power reveals no cracks.

I have evidence to show that very satisfactory business resulted to many people. This was not our primary purpose, but improved business is essential to social development, so perhaps I might relate that very large numbers of extra passengers were carried by the transport authorities. During the first week practically every available char-a-banc was in use. The number of people who took pleasure trips on the river was well over eighty thousand. A number of other industries benefited, and what looked likely to be one of the worst Septembers on record became for many in London a good one.

To see every evening large numbers of people enjoying the walk by the riverside and in St. James's Park was to be convinced that a useful work had been accomplished in Central London, and many other places in the country had similar experiences.

I do not believe that it is correct to look upon it as a great waste of money—a great extravagance. Anything beyond a trifle of food and a blanket can be so described. Beautiful pictures, poems or music are recognized to be great civilizing influences, and to have such pictures as were to be seen in London for the all-too-short period of three-and-a-half weeks, to cheer tens of thousands on their way home from work, at a total annual cost of something of the same order, if not actually less than, the purchase price of one high-grade motor-car, seems to me to be a business proposition, and not an extravagance, for the greatest city in the world.

As I believe a great many people would be ready to agree that to have a number of our buildings visible in the evening as well as during the day might be a justifiable expenditure even in hard times, some further reference to the cost must be made.

Cost is, of course, a matter of perspective. Architecture has been defined as the art of erecting expressive and beautiful buildings, and buildings cannot be expressive or beautiful if they cannot be seen, and they cannot be seen without light. The actual work the architect does in making the façade of his building expressive and beautiful consists solely in providing surfaces which by the varying reflecting qualities will create a beautiful picture expressive of the building and its purpose. Unless there is light nothing of the sort has been produced, and now that the production of artificial light has reached a stage where plenty of it can be provided just where required, at a reasonable cost, the architect has not only the opportunity of a much fuller expression for his culture, but its results can be appreciated for a much longer period of time, and by more people. In other words, whilst the architect in so far as the actual structural work is concerned is in a sense simply a constructional expert, for the rest he is, so to speak, a manipulator of light, a manufacturer of reflecting surfaces, and must either learn to use the artificially produced light on the exterior of his works, as much as he has to learn to use daylight; or, alternatively and perhaps better still, he must make use of the qualified lighting engineer during the progress of his design work.

Large sums are frequently spent on the architectural decoration of the façade of an important building, which decoration can only be seen by daylight, often in these climes of limited duration. For a small additional percentage of these sums a suitable lighting equipment could be installed and endowed in perpetuity (and would never cost anyone a penny piece hereafter) rendering the beauties of the building visible by night as well as by day.

The money spent on the design features or decorative treatment of the façade of a building is solely for the purpose of its being seen, and in a city in many cases the extent to which it is seen may be nearly doubled by lighting it in the evening, and in view of the greater leisure in the evenings it is equivalent to much more than double. Take, for instance, the façade of Buckingham Palace. Five per cent. of the present-day cost would go far towards the installation and endowment of a satisfactory lighting equipment.

Many examples of the inexpensive nature of the lighting carried out during September have already appeared in the daily press. A sum of £5,000 would equip and endow in perpetuity the proper lighting of the façade of the National Gallery. That is, after that sum was provided it would cost the country nothing to keep the installation in operation every evening. £10,000 would do the same for the Clock Tower—sums quite trifling to many well-to-do citizens that it can surely not be long before offers to provide these improvements will reach the Office of Works. Is it not really a business proposition for London itself?

Those wonderfully beautiful views of the Horse Guards Parade and Foreign Office, seen from the bridge in St. James's Park, could be maintained for the same sum that it costs to keep one London policeman.

Another way of looking at it is this: one per cent. of the expenditure of the B.B.C. on music and entertaining would maintain the floodlighting done in London for the Congress for a whole year, and provide illuminated fountains in Trafalgar Square as well, and still leave a substantial margin over.

The illumination of stretches of landscape, or trees and flower-beds in the parks, and the provision of suitable pavilions from which the views could be seen and enjoyed, whilst tea or coffee was being partaken of, would seem to be an amenity of value, and I should think the landscape lighting need not then cost the public purse a penny piece.*

I hope I have said enough about the cost, but before leaving the question of money entirely, and getting to the technical business of the meeting, I would like to refer to one other aspect of floodlighting. Those who carried out the floodlighting

* The pictures kindly prepared for this evening by Mr. W. James and Mr. Herbert Finn show what might be done in St. James's Park.

An Imaginary Night View of St. James's Park, from a Lakeside Restaurant.

showed that by the expenditure of a comparatively few thousands of pounds in a useful way, in a way where self-interest was not the dominant note, a public interest was created which would have cost millions of pounds had the ordinary ways of creating public interest by advertisement been employed.

I believe there is a lesson to be learned here by those responsible for public advertising and salesmanship, and I will make a brief diversion to state a case. Let those responsible for the Hospital at Hyde Park Corner, for example, located as it is on one of the finest sites in London, refrain from what I feel can almost be described as prostituting their property with advertisements as a means of raising money, and instead invite the advertisers to paint and floodlight their building so that it made an attractive picture instead of what in such a position is almost a sordid one. The advertiser could be permitted to have a very small notice, only visible to those close by, and be left also to make his general press announcements, and in other ways make such use of pictures of the building as he saw fit, I believe a satisfactory commercial return would be assured. I believe that an experiment of this sort by one of our national advertisers would prove both to advertiser and hospital that a beautiful contribution to the life of the city was a good way to secure an effective financial return from its citizens.

Taking another example: there are many streets in London and its suburbs with bare plots of land awaiting new buildings, utterly disfigured with advertisement hoardings. I venture to suggest that if the advertisers refrained from using hoardings, turned the waste land into a little garden, floodlighted at night, with a small notice stating who had provided it, they would find it, in certain cases, better advertising than the disfigurements which are at present so prevalent. I am certain in my mind that the lighting engineer with the illimitable possibilities of floodlighting has now an opportunity of developing a new cult of advertising in place of the present blatantly self-assertive methods.

One of the lessons I think should be taken to heart is that the expenditure of one-half the present outlay of the railway companies on advertising the beauties of the districts they serve, if devoted to lighting some of the beauty spots in those districts, would I feel sure bring a return far greater than that produced by present methods.

The cities of this country which now advertise their attractions should also most carefully consider whether they should not allocate a large part of their next year's allowance to the local electricity and gas people, with the help of the lighting engineer, in order to make their place more worth visiting, rather than use their money on merely inviting people to come.

The critics of floodlighting had during the Congress a unique opportunity for the study of the lighting of buildings dating back to William the Conqueror, whilst others were not finished. There were installations which provided over 20 foot-candles, and others down to perhaps ½ foot-candle, with other variations equally pronounced.

To-night we are inviting as much constructive criticism as possible, and the illustrations which are shown are for that purpose, and you are here primarily to establish, by your contributions to the discussion, a better understanding of the principles underlying floodlighting.

[The comments of the author were accompanied by a series of lantern slides showing side by side photographs of the buildings under daylight and under floodlight.]

The strongest objection I heard to the floodlighting was that it made distorted pictures, due to the lighting being in the wrong direction, and I want to deal with this point fairly fully.

I am not in any sense a qualified architectural or art critic, but I can appreciate that after an architect has devoted a life-long study to his subject and puts his whole experience into the design, producing a refined and dignified effect, where, without a cultivated artistic knowledge something crude and unsatisfactory would result, he is naturally anxious that an untrained lighting engineer should not come along and, solely to make the building visible at night, be allowed to spoil that beauty for which the designer has striven for so many years before he could achieve it.

I am prepared to be very sympathetic with the contention and prepared to submit to darkness rather than vandalism but, practically speaking, I think there is much less in this cry than the critics of floodlighting make out.

I do not see any reason why the night picture should be the same as that of the day. For one thing, in many cases you have a dark surround in place of a light one, and if a different picture is presented in the evening from that of the morning, does it matter, so long as it remains a beautiful picture?

It has often been pointed out how the ornamentation on a building is necessarily appropriate for the type of daylight usually prevailing. It must not, however, be forgotton that the angle at which sunshine or daylight strikes a building may vary over many degrees, or that the light in this country may as often be diffused as sunny. The angle from which a building is looked at varies in many cases from an almost horizontal to an almost vertical direction, and finally, the reflecting values of the surfaces vary with time in a way that the architect cannot foresee with any exactitude, so that architectural decoration is necessarily a compromise.

I hope, therefore, that no one will accept the criticism that because the artificial lighting is in a different direction from daylight, it is necessarily wrong.

Mr. Gaster and Mr. Dow many years ago pointed out the interesting way in which artificial lighting could completely reverse the contrasts, and yet, as the illustration shows, such reversal is no injury. This picture is, I feel, a classic.

The question of the effect of the direction of lighting is, however, no doubt quite an important one, as it is by the exercise of control over this that the best results are to be attained. Here the necessity

for the architect to secure the services of the lighting expert to assist him to design the floodlighting for his buildings is clearly seen, and for buildings already erected.

Most of the cases refer to the lighting of existing buildings, although Thames House was one outstanding example of a building with the floodlighting designed by its architect, and the building itself no doubt designed with a view to the floodlighting. St. James's Park also had to be taken as it was, and could not be planted with trees and shrubs specially for this brief occasion.

In some cases the buildings stand out, forming a picture which cannot be related to the general lighting of the street. In other cases there is a close relationship between the buildings. In Whitehall, we had a case where the street lighting was raised to a standard such that the buildings were in part well lighted. If these street lamps were about three times as high as at present, or so arranged that part of the lighting from the fittings was directed upwards on to the top part of the building they would provide a suitable lighting for the buildings in that type of street, and there are many of that type.

I should like to see some experiments made in Whitehall with some upward directed light before the present temporary work is removed. The temporary lighting of Whitehall for the Congress, to my mind, was more valuable as indicating the possibilities of lighting both building and roadway than as an example, simply of roadway lighting.

Daylight in a city seldom provides horizontal lighting of any great intensity, so that it might be anticipated that there would be a greater degree of artificiality in the cases where artificial lighting was in this direction. To a certain extent I think we see this in the examples on the screen.

While some may be satisfied with a picture which appears to be flat, or in one plane (and there is a school of artists who, following the practice of the past, produce such work to-day), I personally prefer pictures in which the third dimension, the distance, is well cared for, whether the study be one of flowers, a portrait, a landscape or architecture.

There is, however, something attractive in two-dimensional pictures, and I would not say that a building which when floodlighted so as to produce a flat effect was necessarily bad. For example, in cases where the charm comes from the effect produced by the play of the black and white which forms in London on Portland stone, it is quite possible that the original architectural features have taken a secondary place. Personally, I thought the towers of Westminster Abbey were the best example of a two-dimensional picture, this effect disappearing as soon as one was some distance away. The reason it was flat was, I thing, not far to seek. It was not possible to place projectors just where they would be best—they had to go in one place only. The lighting was horizontal and there is much black and white.

The best example of the attainment of the third dimension by deliberate effort was perhaps the Victoria Memorial. Here was a special problem. The silhouette of the Memorial against the lighted background of the Palace was very ugly, so the Memorial had to be illuminated. The use of two colours produced a suitable rounding to the Memorial, as well as providing the necessary contrast to the Palace.

Of the Palace itself I need say but little. Those who undertook this work rose nobly to the task, and determined to show something corresponding with the "fierce light which beats upon the Throne."

My impression is that just as the present King gains affection, so sound is he in all his public duties, by having the blaze of publicity on his actions, so the Palace gained something by being in a blaze of light, and I believe that thousands of people appreciated its architectural features for the first time, even though they had passed by many times before.

In this case I heard equally qualified people say that the architecture showed greatly to its advantage in the artificial light, and also that it destroyed any pretence to beauty that the Palace ever had.

I believe Mr. Ritchie and his associates were right in doing the job as they did, although I did my best to have it done in another way, and I still regret that we did not see it both with half the intensity and carried out with an almost vertical projection. I believe that the Palace ought to be illuminated every night, projectors placed near the building might be possible as a permanancy, and might, I think, produce a more satisfying result if a permanent installation is contemplated.

The problem of making attractive a long strip of building like Somerset House was, I should imagine, one not easy of solution. In daylight the building forms part of one of the most attractive vistas over London. Lighting it at night as an isolated unit called for considerable judgment, and, in my opinion, the adoption of a coloured-light scheme was not only a useful contribution to the general diversity aimed at for the occasion, but was in itself something of an inspiration for which Mr. Wheat is to be congratulated. As far as I could gather, the coloured lighting received both more active protest and more active commendation than any of the installations. It was a daring experiment for London, a city commonly thought of in terms of black and white, but one fully justified. I am sorry the colour was not maintained all through the period.

Close by was to be seen the Institution of Electrical Engineers, with the innovation, suggested by the Lighting Service Bureau, of illuminated finials to the light stone corners of the red-brick building. These were, in my opinion, much too bright, and from some angles they spoiled the effect of Somerset House. I mention this only to call attention to the necessity of considering each lighting installation in relation to others. The lighting of the red-brick Institution building is, I think, not yet entirely satisfactory, and I hope that some experiments with colour screens and a still further diminution of the intensity of the light on the finials will be made. It is, however, a very useful example, as it is perhaps the worst type of building likely to call for lighting.

On the other side of Somerset House was one of the gems, not seen, however, by nearly enough people—the Incorporated Accountants' Hall lighted with lamps with daylight screens made a perfect moonlight effect, and provided a picture which I retain with feelings of great pleasure. Here we had also an example of an appropriate light inside as well as out.

I do not know why Mr. Downer decided on daylight lamps, and I hope he will tell us, and try to establish the conditions which make this form of lighting most suitable.

A street lamp tended to spoil the effect, and so we turned it out, a procedure not to be commended generally, but if this installation is made permanent those responsible for the street lighting will, I am sure, move that lamp.

The County Hall, with its semi-circular façade, gave Mr. Hughes a very difficult task to light it temporarily in a satisfactory manner, and per-

manent provision should be made. The lighting of the top caused the difficulty, as it was difficult to screen the lamps. The result from across the river was very attractive, and before long I hope the whole building will be illuminated.

Trafalgar Square looked dead after the lighting of the National Gallery was turned out, and it still looks dead. The play with two colours and the combination of reflected light and silhouette was as much in the right direction as a temporary job could be, and I feel certain that the great majority of the thousands who passed by would willingly see the trustees devote the small sum necessary in order to make a beautiful picture of the outside of the gallery for all to see every night.

I do not think I am expected to criticize all the work done, but I cannot leave the subject without a reference to my favourite view—the Horse Guards Parade buildings, seen from the bridge over St. James's Park lake, with the background of the War Office and Whitehall Court, a picture in daylight which defies the superlative. Mr. Hall picked this out with projectors placed 600 feet away, and my only regret is that the owners of Whitehall Court would not join in. However, the picture was beautiful, and, in association with the Foreign Office, for which Mr. Hall provided the necessary projectors at very short notice, showed how in some cases very low intensities are appropriate, for here was one foot-candle, compared with over 20 at the Palace, and St. James's Park Station.

One lesson learned on this installation is that long-distance projection is not the best for London, as a slight mist produces very considerable interference, and the low-lying clouds tend to spoil the result.

The Clock Tower—Big Ben—and the Tower of Westminster Cathedral were two very different examples of buildings standing right out against the sky. The Cathedral tower was lighted at a very much lower intensity than Big Ben. It was, however, visible over curiously long distances, due, I should think, to the fact that the architect has used two colours in bands all the way up, no doubt to make it catch the eye. It does catch the eye, and, in my opinion, a tower of this height was a great opportunity for an architect not taken advantage of. The lighting engineer, I believe, made the best job possible of it by not overlighting it and made it quite attractive at night.

The Clock Tower offers opportunity for some useful criticisms from the artists present. One side was lighted at quite a different angle from the others.

Whatever may be said by the art critic, it was a very attractive piece of work, calling for projection of a high class, and Mr. Stroud and Mr. Hughes did it, I feel, in an entirely satisfactory manner. The lighting of it should be made permanent as soon as the reconstruction is done, and further during the reconstruction now going on any provision necessary for floodlighting should be made.

The plaster model of Big Ben exhibited was very kindly loaned by Mr. Wilson, and fitted with model lighting by the Lighting Service Bureau. It provided an oportunity for illustrating the effect of directional lighting.

The other architectural examples for this purpose have been prepared by Mr. Maitland, of the Bureau.

[The author here showed by means of small projectors the effect of artificial lighting in different directions. He contended that the demonstration showed that artificial lighting could produce satisfactory results.]

As to landscape and flower-bed lighting, this offers other problems. The great difficulty is to hide the source of light, and permanent appropriate screens of shrubs will have to be provided. St. James's Park showed how attractive this form of lighting could be. This example was seen by thousands, and should lead to there being large numbers of lighted parks and gardens. I think it should soon become a permanent feature.

The illustration of Edinburgh Castle shows that an entirely different problem is presented from any of those shown. I think it reflects not only a beautiful picture, but much credit on those

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APPENDIX I.

INTERNATIONAL ILLUMINATION CONGRESS.
FLOODLIGHTING OF PUBLIC BUILDINGS (September 1st to 25th).

This programme of illumination was carried out free of charge as follows:—

ELECTRIC SUPPLY ...	The London Electricity Supply Association.
ELECTRIC WIRES AND CABLES	The Cable Makers' Association.
GAS SUPPLY	The Gas Light & Coke Co.
BUCKINGHAM PALACE	The General Electric Co. Ltd. Messrs. Troughton & Young Ltd.
CLOCK TOWER (Houses of Parliament)	Messrs. Holophane Ltd. Messrs. Siemens Electric Lamps and Supplies Ltd. Messrs. T. Clarke & Co. Ltd.
COUNTY HALL ...	Messrs. Siemens Electric Lamps and Supplies Ltd. Messrs. Rashleigh Phipps & Co. Ltd.
FIRE FLOATS OF HUNGERFORD BRIDGE	London Fire Brigade. Messrs. Siemens Electric Lamps and Supplies Ltd.
FOREIGN OFFICE ...	Messrs. John I. Hall. Messrs. Brown Bailey's Steel Works.
H.M.S. "SCOUT," IN POOL OF LONDON	Admiralty.
H.M.S. "PRESIDENT," VICTORIA EMBANKMENT	Messrs. J. Mowlem & Co. Ltd.
HORSE GUARDS BUILDINGS ...	Messrs. John I. Hall. Messrs. Brown Bailey's Steel Works.
INCORPORATED ACCOUNTANTS' HALL	Society of Incorporated Accountants and Auditors. Messrs. Belshaw & Co. Ltd. Messrs. Restlight Ltd.
INSTITUTION OF ELECTRICAL ENGINEERS BUILDING	Institution of Electrical Engineers.
LANDSCAPE LIGHTING IN ST. JAMES'S PARK	The Gas Light & Coke Co.
NATIONAL GALLERY ...	The Strand Electric & Engineering Co. Ltd.
NELSON STATUE ...	The Strand Electric & Engineering Co. Ltd. The Stelmar Projection Lighting Co.
ST. MARTIN'S CHURCH	The Strand Electric & Engineering Co. Ltd. The Stelmar Projection Lighting Co.
ST. PAUL'S CATHEDRAL ...	27th A.A Battalion R.E. (Territorial Army).
ST. BRIDE'S SPIRE ... BOW CHURCH SPIRE	26th A.A. Battalion R.E. (Territorial Army).
SOMERSET HOUSE ...	Messrs. Edison Swan Electric Co. Ltd. Messrs. Cecil Cooper & Co. Ltd.
THAMES HOUSE ...	Imperial Chemical Industries.
TOWER BRIDGE ...	Bermondsey Borough Council. Stepney Borough Council.
TOWER OF LONDON...	The Benjamin Electric Ltd. Messrs. Anderson, Angell & Co.
VICTORIA MEMORIAL...	The General Electric Co. Ltd. Messrs. Troughton & Young Ltd.
WAR OFFICE TOWERS	Messrs. John I. Hall. Messrs. Brown Bailey's Steel Works.
WHITEHALL SPECIAL LIGHTING	The Gas Light & Coke Co.
WESTMINSTER ABBEY	Messrs. Holophane Ltd. Messrs. Siemens Electric Lamps and Supplies Ltd. Messrs. Bell Bros. & Co. (London) Ltd.
WESTMINSTER CATHEDRAL (TOWER) ...	Messrs. Lewenz & Wilkinson Ltd. Messrs. Baxter & Caunter Ltd. Messrs Norrington & Landon Ltd.

responsible for the lighting. Here you have a building of unique character dealt with by the lighting engineer with a reverent touch. The illustration shown is the photograph conveying the last impression of the castle as I saw it.

I would like to have referred to the Tower of London, the Tower Bridge, the town halls and war memorials, which were lighted for the occasion, but the time is too short, so I will conclude this summary with a brief reference to the lighting of the dome of St. Paul's Cathedral and the church spires by means of searchlights. These are not the best instruments, but the officers and men in the battalions made most effective use of them, and I myself in common with thousands was very grateful.

St. Paul's is a great landmark in more ways than one, and if the Dean and Chapter would authorize the installation of appropriate floodlight projectors for permanent use, I believe they would have the satisfaction of finding that they had provided an unfailing source of inspiration, and a nightly opportunity to very large numbers to look upwards to the symbol which surmounts the dome.

In conclusion, please forgive me if I have been crude. I am only an amateur, here to start you all constructing a still brighter London by your criticisms of the efforts of those responsible for the floodlighting in connection with the International Illumination Congress.

I believe it is essential that we refuse to look upon the venture of lighting our public buildings last September as merely a stunt show. It was the beginning in London of a normal development in the life of the city. Floodlighting is not solely the servant of the merchant, nor a mere utilitarian means of illumination. It is an opportunity.

There is a great field open for outdoor lighting of every sort, of which floodlighting is perhaps the most useful, and I only wish it were possible to maintain the close co-operation between the gas and electrical interests which my London Committee enjoyed, so that in their future development of a great lighting programme they would waste none of their efforts in strenuous competition with each other, but devote them all to making more visible the amenities of this wonderfully beautiful city, and to the social advantages which better lighting of every sort brings to the great masses of the people dwelling therein.

DISCUSSION

The CHAIRMAN, after congratulating Mr. Good upon his address, remarked that the subject was of exceptional interest to architects, whose views on floodlighting the Society was anxious to hear. He would therefore call upon Mr. Howard Robertson to open the discussion.

Mr. HOWARD ROBERTSON said that the paper was of extraordinary interest. Mr. Good seemed to have great sympathy with architecture (not necessarily with architects!). As an architect he himself was conscious of a certain conflict of impressions in regard to floodlighting. There were great possibilities in this method of lighting, but it should be applied with discrimination. If it became a general practice, it would certainly show up the deficiencies of architects in certain cases. There were in London many buildings that did not deserve to be floodlighted, and would be better left hidden in the darkness. Floodlighting was clearly capable of abuse. He thought that there was a general feeling that we had not yet approached the ultimate beauty of effect that was possible. It was desirable so far as possible to concentrate attention on the floodlighting of objects worthy of distinction. Certain buildings do not readily lend themselves to the process—for example, he doubted whether the essential quality of the British Museum could be revealed by floodlighting.

Furthermore, the mere illumination of masses of stone would soon become wearisome to the public, and it was advisable to seek for variety. He did not think that it was necessary or even desirable to imitate daylight effects. During the daytime one did not get much colour in buildings, but by using artificial light after darkness had fallen the colour element could be introduced. He thought that one of the most interesting effects in the London display was the pink glow over Somerset House. In many cases it might be useful to supplement floodlighting by local illumination, possibly by local colour effects. The use of coloured light in the streets by night would help to create interest and leave a cheerful impression. In some cases the production of scenic effects might be considered.

Mr. T. F. BENNETT also commented upon the interesting character of the paper. Mr. Good, as a layman, had fortunately been able to avoid some technical difficulties in which architects and engineers were apt to become involved. He was satisfied that floodlighting had come to stay, but he believed that there was not yet a sufficient grasp of technique to get the best effects. He had observed that in the case of certain otherwise very successful installations, such as Westminster Abbey, there was a tendency for buildings to appear as though cut out of cardboard or plaster. It must surely be wrong to cause architecture in stone to look like the painted architecture of the stage.

The positions of lights required considerable study and it was often difficult to predetermine on paper the angle from which light should be directed. It was sometimes difficult to avoid the light-source becoming visible, and in some cases the comfort of inmates of a building had to be studied—it would be unfortunate, for example, if a hospital that adopted floodlighting for purposes of publicity allowed the beams of the projectors to be directed on the eyes of patients or nurses! Some mercy should be shown to the occupants of buildings.

Another point that needed study was the relation between the direction of the light and the nature of the shadows cast. In some cases pieces of sculpture with a maximum projection of about $1\frac{3}{4}$ inches produced extraordinarily shaped shadows when floodlighted simply because one piece of modelling was a fraction of an inch in front of another. Such projections often could not be seen with a top light, but they immediately became evident when the building was illuminated from the bottom. Many façades were so good that they could be lighted from any direction, but others were not.

In regard to the use of coloured light, which the previous speaker had recommended, it was necessary to remember that people's eyes varied, and that the man in the street often formed strange impressions of colour. He himself had been told that he had used many colours which he was sure were not present. It was necessary to make use of the services of someone who really understood colour when contriving installations based on coloured light.

He felt sure, however, that the result of the illuminations in September would be to give floodlighting a lasting place in the architecture of the future.

Mr. OLIVER BERNARD wished to express his appreciation of the address. Like Mr. Good, he professed to be merely an amateur in this subject. He felt, however, that the lecturer would be a valuable ally to any architect who had difficulty with his

clients on the question of the cost of an electrical installation. A man who could say that it cost merely £5,000 to illuminate permanently the façade of the National Gallery was the very man he needed to back him up!

The Secretary of the R.I.B.A. had perhaps shown a peculiar sense of humour in asking him (the speaker) to attend. Mr. Good had referred to the beauties of architecture in certain buildings, but when he (the speaker) looked at some of the most expensive and venerable of our archæological monuments amongst our buildings he was inclined to say "Thank God for the night."

Assuming the outlook of an amateur knowing nothing about the floodlighting scheme, and reviewing his impressions on arriving in London, he might be inclined to say that, on the whole, the display was a little crude and a little monotonous, and might be described as "an outbreak of foot-and-candle disease." (Laughter.) In some parts of the paper it had been suggested that architects should make use of a qualified lighting engineer during the design and progress of their work. He himself began the study of lighting effects thirty years ago, when gas-light was still used in theatres. In those days the illuminating engineer was unheard of. He (Mr. Bernard) was still trying to discover exactly what was meant by the term!

There was, he thought, a tendency amongst those who regarded themselves as illuminating engineers to think very hard on the theoretical side and very little on the inspirational side. After all, whether one tried to create pictures by night or to add night pictures to day pictures, the process was not merely a matter of providing so many foot-candles. That was rather like trying to get a picture into the Royal Academy by saying "so much red lead and so much crimson lake and so on have been used." The impression on the President of the Royal Academy might be somewhat unsatisfactory. He would judge the picture by the result, and would not care an iota about what had been used or the method.

He would suggest that the lighting industry should employ, in addition to the gentlemen who knew all about watts and foot-candles, somebody who had an eye for effect. The ideal man to make Buckingham Palace look bearable by night was a good scenic artist.

In a sense, the lighting industry was entering upon a sphere the eventualities of which it had not really grasped. Such ideal men as he had indicated were at present scarce. The day would come when the artistic, the creative mind must drop the occupation of making toys, pictures, and pieces of sculpture—in fact the fine arts—and turn to what was commonly described as applied or industrial art. If they could see such men as Benvenuto Cellini applying their gifts for composition in colour and form to industrial processes such as floodlighting and interior lighting they would not talk about illuminating engineers any more than they talked about colour manufacturers in relation to pictures. They would accept the means, the end being the important thing.

Mr. F. C. Smith referred to the floodlighting of St. James's Park with gas, which had been mentioned in Mr. Good's paper. Floodlighting was regarded by the gas industry as an entirely new field. Naturally there had been many difficulties to surmount, and there was still a good deal to learn. However, they felt that their efforts had met with a fair share of success, and that the industry was still pushing forward in an endeavour to make a substantial contribution to floodlighting.

His experience had been similar to that of others, namely, that the display had aroused considerable interest and had led to enquiries with prospects of further development. He would like to show a few lantern slides illustrating the floodlighting of the library at Barking during the Carnival week. Sixteen projectors were applied in this case quite successfully, and a small lodge at the entrance to Barking Park was also illuminated by three projectors.*

Mr. E. Stroud paid a tribute to the admirable manner in which Mr. Good had got together various interests and induced them to unite in the most wonderful display of floodlighting yet arranged in this country.

The lighting of Big Ben Tower, with which he (Mr. Stroud) was concerned, was rendered difficult by the considerable height of the tower, the angles of throw and the colour of the material. The absorption of the lightest parts of the stone was about 66 per cent., but the darker portions absorbed about 90 per cent., and the belfry even more, with the result that 40 per cent. of the projectors were used for this region alone.

Mr. Stroud then proceeded to describe the method of lighting, explaining that the surface of the tower below the belfry, an area of 9,000 sq. ft. per side, received illumination from 22 1,000-watt projectors, equivalent to 2.5 watts per square foot. He also described the special local lighting of the belfry, and the interior lighting of the clock with amber lamps, to which reference has already been made in this journal. He stated the surface brightness was about 7 foot-candles at the clock face and 3 to 4 foot-candles on the lighter portions of the stonework.

Westminster Abbey was a more simple job, as projectors could be mounted on the flat roof of the Central Hall (giving a nearly normal throw), and the stone was of lighter texture than that of Big Ben Tower. In this case the consumption of energy was about 1 watt per square foot, with a surface brightness of 1.5 to 2 foot-candles. St. Margaret's Church Tower was lighted from the same vantage point. Only four 1,000-watt projectors were trained on this tower, the throw being about a quarter of a mile.

The stone of this tower was still lighter, so that effective results could be obtained with a relatively low consumption.

He would like to deal with one point raised by Mr. Good by assuring him that, in his experience, the effort during the Congress had been well worth while. His firm had undertaken a considerable number of floodlighting installations in various parts of the country, including the new Town Hall at Wimbledon, which was about to be opened by Prince George on the following Thursday.

Mr. H. C. Wheat also congratulated the author. There was one other section of the lighting industry whose work deserved special recognition, namely, the wiring contractors, on whose efforts the completion of these installations so largely depended. Reference had been made in the paper to the effect of lighting units on high standards, such as those in Whitehall, in illuminating the surfaces of buildings. Mr. Wheat showed an effective picture of the Sunderland War Memorial showing the successful application of this method, which had been adopted elsewhere in this country.

In conclusion, Mr. Wheat remarked that there was a tendency to assume that floodlighting in this country was quite a new thing. This was hardly the case, as was shown by another lantern slide of Leicester Town Hall, illuminated in 1918. Seventy-two kilowatts were used for this installation, which was thus a fairly large job.

Mr. T. E. Ritchie said that he was one of a group concerned with an installation which had received the most scathing condemnation and the greatest

* *Illum. Eng.*, November, 1931, p. 297.

admiration. Buckingham Palace was floodlit under conditions laid down for, and not formulated by, those who did the work. There were a number of difficulties and drawbacks attaching. If he might be allowed to say so, they made a good job of the work. He disagreed entirely, completely, and fundamentally with Mr. Good, who said that he would like to see the Palace illuminated to half the intensity, with the projectors placed much nearer to the walls. That would have been entirely wrong, and Mr. Good would not have liked it. There was never too much light on the Palace. The intensity was very slightly higher than that which was always present at the White House in Washington. There was considerably less light on the Palace than there was in connection with other installations.

Further, Buckingham Palace was not flat. There was a much greater variation in intensity than many people supposed, and as he (Mr. Ritchie) would demonstrate with lantern slides, the architectural effects were much more perfectly and pleasingly revealed than by daylight.

The mass of the projectors were placed at the bottom left-hand corner, and the light came diagonally in two directions. One could see the reeding, the capitols, and the ornamentation. There was, however, one circumstance that went far to explain the impression of monotony. People were inclined to describe a thing as "flat" when they meant that most of it was of the same colour. When Buckingham Palace was floodlit the blinds were drawn. But when they were up, instead of the building appearing inanimate, there was something sparkling and living. That was a vital point to remember. The blinds should be blue or black, and not a buff colour almost identical in shade with the colour of the stone, if effective floodlighting was desired.

[At this stage Mr. Ritchie showed lantern slides of the Palace with the blinds up and down, but with otherwise identical conditions, and pointed out the remarkable difference in appearance.]

The meetings of the Society were famous by reason of the fact that they made history. The slides shown that evening marked another milestone. Those who visited the Physical Society's Exhibition might remember the telephotometer, a combination of the telescope and photometer. The instrument had been developed by his colleagues in research laboratories and was now making rapid headway. The intensity varied between 5 and 35 foot-candles, and the variation was sufficiently irregular to make distressing or objectionable flatness an absolute impossibility.

Turning to other installations, Mr. Ritchie mentioned that in connection with Thames House they had the inestimable benefit of the co-operation of the architect. In his opinion, the Institution of Electrical Engineers, in its present condition, ought never to have been floodlighted. The surface of the building badly needed steam cleaning, and until that was done he thought that criticism was premature.

Mr. L. G. Applebee explained that he had been one of those responsible for the treatment of the National Gallery and Nelson's hat. (Laughter.) The National Gallery was rather a peculiar job, and there were an enormous number of street lights to contend with. He recalled that Mr. Good and others had inspected the original lighting, and they expressed themselves as thoroughly pleased, and thought that the intensity was quite sufficient. His directors, however, thought differently, and therefore the intensity on the portico was increased by 100 per cent., and in other cases by 50 per cent. Actually, however, this change had made no material difference in the general appearance. The stonework of the building varied. Some portions with white light on were a sandy red and others were grey.

With regard to "Nelson," the object was to show what could be done with the 30-volt 30-ampere lamp. Three 90-watt lamps were used. The idea was to illustrate the efficiency of this mode of lighting rather than to create a blaze of light.

Mr. J. T. Hall briefly expressed his interest in what had been said on the architectural side.

Mr. F. L. Calvert mentioned that Mr. Good had emphasized the desirability of avoiding the exposure of lanterns when viewed from different aspects. He thought that the gas company ought undoubtedly to be congratulated on the manner in which they had handled a difficult problem: if it were possible to arrange for effect to be viewed from one aspect only, this would, he thought, have been an improvement.

Colonel C. H. S. Evans (Hon. General Secretary, International Illumination Congress, 1931). (*Communicated*). I congratulate Mr. Good on his opening of this discussion, and I hope that his remarks and those of other speakers will reach an even wider audience than the large one present; he makes some interesting suggestions and boldly puts forward answers to certain criticisms.

It is of interest to note that in a series of 1,500 press cuttings on the files of the Congress there are only seven adverse criticisms of the floodlighting in September, and I think three of these might be mentioned, and I do so without comment:—

> "The floodlighting of Buckingham Palace has failed in effect by reason of want of contrast."
>
> "Floodlighting of the normal glare type aimed from a distance merely illumines the corpse-like face of 'dead' architecture, and does not bring it to life as the light of day."
>
> "The effects obtained in London, as well as in Paris, reveal floodlighting as an art conceived, but as yet unborn."

I should like to take this opportunity to mention a point, and I do so as Honorary General Secretary of the Congress; I wish to place on record our thanks to the London Electric Firm for their help; the speedy alteration of their searchlight projectors, which they placed at our disposal for tests, was most valuable.

Mr. G. V. Downer (*communicated*): I would like to add my tribute to the excellence of Mr. Good's paper. I respectfully differ from Mr. Robertson when he implies that artificial daylight should not be used for floodlighting. I believe that the use of artificial daylight is greatly superior to uncorrected or coloured light on a building of outstanding architectural merit, and especially one constructed of Portland stone which has weathered. I do not claim that it would have anything like an equal value on red brick or on a brand new building. My aim was to retain as far as possible the actual *daylight* but not *sunlight* appearance of the very beautiful building which my firm was privileged to light. Shadows were to be soft, and the lovely effect of the weathering had to be preserved. Much favourable comment went to show that to a large extent these aims had been achieved. In view of Mr. Good's remarks on horizontal lighting, I ought perhaps to mention that the lighting was for the most part horizontal. The intensity was intentionally low, producing the "moonlight effect" referred to by Mr. Good. The light at its source is actually rather warmer than diffused sunlight, while moonlight is, of course, the whitest and purest form in which light reaches us from the sun.

Mr. H. Long (*communicated*): As the floodlighting of the Tower of London, in common with other installations, has already been fully dealt with in the

journal, I did not wish to occupy the time of the meeting with further description.

As, however, this installation only received passing mention in the paper and was not, I think, commented upon at all at the meeting, I should like to draw attention to the fact that it did in fact form part of the official programme, which was generally admired. Possibly this installation was apt to be overlooked owing to the fact that it could only be seen within the grounds of the Tower of London and therefore did not fan so directly in the public eye.

Mr. A. CUNNINGTON (*communicated*): There is an interesting side issue arising from the recent display of photographic records of floodlighting installations.

It must be apparent from the most casual inspection that the effect as shown by a photograph does not always correspond with the actual effect on the eye when the installation itself is viewed. The effect obtained in the photograph seems to be almost entirely dependent on the exposure, and a quite feeble degree of illumination can be made to look like a brilliant shining whiteness by over-exposure.

It has for long been recognized that illumination photographs can easily be faked, but this is hardly a question of just retouching. It would be interesting to know whether the photographic experts could agree on some standard exposure which would ensure a reasonable possibility of comparison between photographs of one installation and another.

Mr. PERCY GOOD, in expressing thanks for the kind remarks that had been made, said that he accepted them on behalf of those who had helped in the preparation of the paper, namely, Mr. Jones, Mr. Maitland, Mr. Galley, and other members of the Lighting Service Bureau.

Dealing with the discussion, Mr. Good said that he welcomed the comments of Mr. Robertson and Mr. Bennett, from which he felt that there was much to be learned. He also hoped that colour effects would be developed. Mr. Bennett and his colleagues had achieved something very fine at the Saville Theatre, and had shown definitely the need for studying the lighting effects with models before the work was put into hand.

Turning to Mr. Bernard's comment, Mr. Good pointed out that in the case of a really monumental building £5,000 was in fact a comparative trifle. As regards the suggestion that this work had really been a piece of propaganda for the gas and electrical interests, those who had undertaken the principal jobs when first approached had not considered that there could be any effective financial return. They had nevertheless agreed to submit the matter for the approval of their Directors as a gesture of welcome to the delegates coming to the International Illumination Congress. The work had certainly been initiated on a basis entirely free from self-interest. Mr. Good agreed with Mr. Wheat that the wiring contractors deserved thanks, and he hoped that those who had worked without expectation of a financial return would get a reward for what they had done for London as a whole and the lighting industry in particular.

Mr. Good felt that the expression "foot-and-candle disease" was a happy one, but those responsible for the installations had shown that they recognized the possibility of such a disease, and had clearly taken adequate steps to prevent an outbreak!

On the motion of the CHAIRMAN, a vote of thanks to Mr. Percy Good for his address was carried with acclamation. In the course of his remarks the Chairman expressed the hope that someone would think of a better word than "floodlighting," which he felt was not entirely a happy one.

Mr. PERCY GOOD having briefly expressed his thanks to the audience, the meeting then terminated.

Street Lighting in Relation to Transport

Proceedings at a Meeting of the Association of Public Lighting Engineers, held in connection with the Public Works, Roads and Transport Congress, at the Agricultural Hall, London, on November 20th, 1931.

THERE was an excellent attendance at a meeting held in connection with the Public Works, Roads and Transport Congress, at the Agricultural Hall, on November 20th, when a paper on the above subject was presented. This paper, which had been skilfully prepared from data and ideas submitted by various members of the Association of Public Lighting Engineers, was presented by Mr. Harold Davies, of Chesterfield (Vice-President). The chair was taken by Mr. R. Beveridge, of Edinburgh, President of the Association. The paper dealt successively with such topics as "The Relation between Street Lighting and Safety," "The Lighting of Arterial Roads," "Illuminated Notices and Signs," "Automatic Light Signals," etc. In the concluding section the formation of a suitably constituted Advisory Council to survey problems involved in public lighting throughout the country was suggested.

In the opening section of the paper Mr. Davies remarked that the streets in most of our larger towns are fairly well lighted. It is mainly in lesser streets that carry more traffic than in the past that unsatisfactory conditions are found. The British Standard Specification affords useful guidance; other simpler rules have been proposed, e.g., that no lamps of less than 500 candle-power should be used in main streets. The height of suspension should not be too low, 18 ft. being usual in the main streets of many large towns and 13 ft. 6 ins. in side streets. Opinions vary in regard to the best positions for lights. Central suspension has recently found favour. On the Victoria Embankment, London, it was almost obligatory owing to the shadowing effect of wayside trees; but on highly polished roads it is liable to give rise to reflected glare.

The limiting of glare from street lamps has long been a matter of discussion. In the streets one finds conditions that would scarcely be tolerated in any other field of lighting. With wide spacing of lamps uniformity of illumination and absence of glare are scarcely compatible, and compromise is inevitable. Provided there is no abrupt transition from bright light to obscurity, gradual variations in illumination on the road surface do not seem to matter very greatly, and the apparent brightness of polished road surfaces may in fact bear little relation to the distribution of illumination. A road surface which is at once dark and highly polished is the worst possible from the lighting engineer's standpoint. The light concrete surfaces used in the United States are said to give better results in this respect. Experiments with coloured concrete surfaces are being conducted in this country.

THE RELATION BETWEEN STREET LIGHTING AND SAFETY.

Turning to the above subject, Mr. Davies recalled the paper presented by Mr. W. R. Beveridge before the National Safety-First Congress in 1930. In

this it was pointed out that many otherwise admirable developments in road design, whilst facilitating the passage of high-speed motor traffic, have tended to increase the dangers to pedestrians. Evidently conditions of artificial lighting in streets must have some bearing on the safety of traffic; yet we lack an adequate analysis of street accidents such as might lead to definite conclusions. In general, no distinction between accidents occurring by day and by night is made, but even when this is done there are many extraneous factors to consider. Statistical data obtained in a large rural area and in a city might bear little relation to one another—for example, the ratio between day and night accidents might be quite different.

An analysis made by Mr. L. Gaster in 1917, based on figures for the period 1913 to 1915, showed that, whilst both day and night accidents were increasing, the rate of increase was considerably greater in the case of the night accidents. In the discussion of the Road Transport Lighting Bill in the House of Commons in 1927 figures were again quoted by Sir Park Goff to show a progressive increase in the proportion of accidents occurring by night. Other recent investigations in Indiana led to the conclusion that "the relative night hazard is about four times the day hazard." Certainly all these inquiries seem to emphasize the importance of good lighting of our roadways by night.

Mr. Davies suggested the need for careful discrimination between day and night accidents and the collection of statistical data on this subject. He remarked that whilst the Public Health Act, 1875, gives the authorities power to light districts the word "may" is used throughout; "shall" should surely be substituted for "may."

Lighting conditions have doubtless an important bearing on the ease with which night traffic can be handled; yet there are few published data comparing the possible speed of traffic in cities or on arterial roads by night and by day. In the case of some forms of industrial work (e.g., typesetting by hand) full efficiency is only reached with illuminations of the order of 20 foot-candles and approaching those available in good daylight. For fine work in factories 5 foot-candles is considered a minimum, and this is possibly higher than the natural illumination often found in the worst-lighted spot. In public lighting the contrast between natural and artificial lighting is very much greater. The minimum prescribed in the British Specification for Class A Street, 2 foot-candles, is scarcely ever attained; yet this is only 1/250th of the avreage value of unrestricted daylight illumination out-of-doors.

The Lighting of Arterial Roads.

The lighting of arterial roads is a somewhat exceptional problem, and special lighting technique has been developed—for instance the use of stationary headlights mounted at the side of the road and at a low level. In the vicinity of towns the method adopted in the urban area would naturally be extended. In some cases confusion in regard to the duty of lighting such outlying areas occurs, and in purely rural areas adequate illumination may be beyond the local capacity. In view of the heavy cost of construction of such roads, adequate lighting, enabling them to be freely used at night, is economically justified. The capital cost might well be ranked with the cost of road making and defrayed as a national obligation, whilst maintenance of lighting should be aided by Government grants. Better lighting should enable such routes to be used more by night, thus relieving day load. and may also induce motorists to leave congested main roads and follow loopway arterial thoroughfares.

Turning to "illuminated notices and signs," the author emphasized the importance of adequate artificial lighting to render such signs visible by night. Simple instructions on methods of illumination should be given. New opportunities for the use of such direct luminous signs giving information are continually arising.

Automatic Light Signs.

Favourable experience of the use of automatic light signals was reported from several cities, and figures were quoted to show the progressive diminution in accidents in Edinburgh since the system was introduced. Some reference to problems of design, such as the avoidance of "phantom" indications caused by the reflection of extraneous bright sources was made. Dr. Hampton, after analysing the factors influencing the duration of the cautionary "amber" signal, has formed the opinion that for maximum safety three seconds is desirable, whilst for exceptionally wide crossings four to five seconds may be necessary.

On most well-lighted thoroughfares in cities the use of headlights is unnecessary, and if arterial roads could be sufficiently well lighted to render them superfluous, this would doubtless help to improve the safety of night driving thereon.

Conclusion.

In the final section of the paper the hope was expressed that ultimately every city of importance would have a qualified public lighting engineer responsible for the control of its lighting. Appeals for aid in such matters as the lighting of arterial roads must naturally bring with them some degree of Government supervision, and in other directions (such as direction signs) it has been found that uniformity cannot be attained by other means. The President recently mentioned, as one of the most judicious and least controversial of schemes for the central supervision of public lighting, the formation of an advisory council on which representatives of such bodies as the Association of Public Lighting Engineers, the Illuminating Engineering Society, the National Physical Laboratory, and the Royal Automobile Club could co-operate with the Ministry of Transport. Such a council could carry out the necessary supervision and initiation of experimental work by which public lighting authorities throughout the country would benefit. By operating on some such lines as these it might be necessary to secure the desirable pooling of experience and union of effort, without local initiative and independence suffering.

In conclusion, acknowledgment was made of the help received from numerous members of the Association and others in the preparation of the paper, including Mr. R. Beveridge, Mr. J. F. Colquhoun, Mr. J. S. Dow, Mr. H. V. Emptage, Dr. W. M. Hampton, Mr. H. H. Humphries, Mr. S. B. Langlands and Mr. Thomas Wilkie.

Discussion

Mr. R. Beveridge (Edinburgh), who presided, said that the Association of Public Lighting Engineers was anxious to take every opportunity of arousing interest in public lighting and discussing the manifold problems involved. They had accordingly been pleased to accede to the suggestion that they should take part in the Congress. He was glad to see such a good audience, and he hoped that the paper which he was now going to ask Mr. Davies to present would lead to a useful discussion.

The discussion was opened by Mr. C. C.

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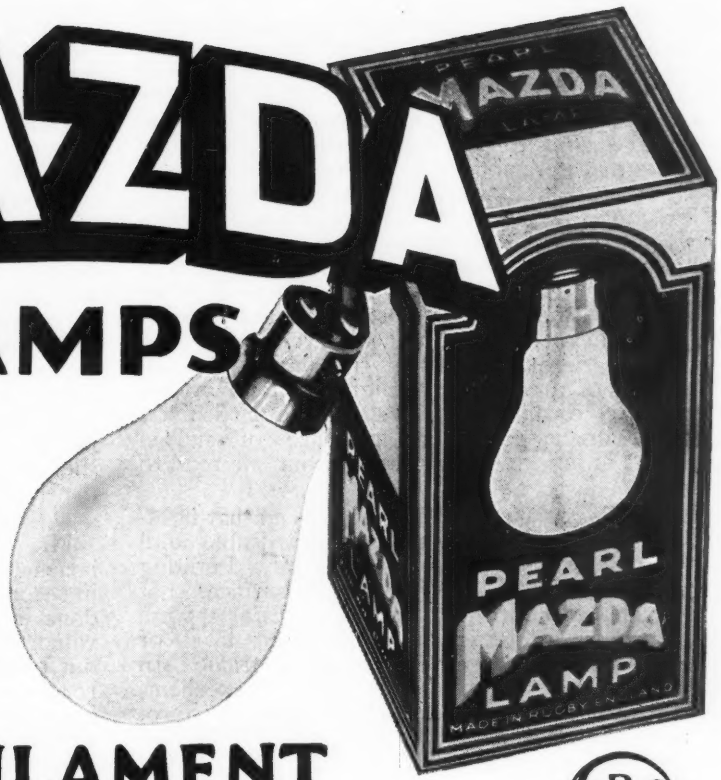

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PATERSON, who congratulated the authors on the orderly and practical arrangement of the paper. He would like to refer to the comment that uniformity of illumination was incompatible with avoidance of glare. He suggested that uniformity was not *per se* so very desirable; it was, however, expedient that the diversity coefficient should not be too high; otherwise the illumination midway between the posts would sink to an unduly low value. He wished to endorse what was said in the paper regarding the drawbacks of black shiny surfaces for roadways. More than half the difficulties of street lighting could be eliminated if only surfaces of lighter colour could be used, and he hoped that some speakers would be able to report experience with road surfaces that were not black. In regard to statistical data on accidents it was evident that not only was a division between night and day accidents necessary, but the night accidents themselves should be subject to classification. The average speed of driving by night was probably less than by day, yet accidents seemed to be more frequent, possibly because unexpected emergencies arose more frequently by night. It was at such crises that the conditions of street lighting might prove important. One source of difficulty that should be particularly guarded against was the presence of sudden contrasts in brightness in passing from one road to another.

Mr. J. C. ELFORD (London) suggested that light-coloured roadways were scarcely practicable until someone produced a form of white tar. Lighting should be adapted to the road surface, not the road surface to the lighting. Efforts were being made to attain an extravagant level of illumination beyond the requirements of traffic. In the specification he considered Class D excellent, and Class C as far as it was ever necessary to go. If main thoroughfares were very brightly lighted the dangers encountered when traffic had to turn into less well-lighted streets were accentuated. The first essential was improved lighting in secondary streets.

Captain W. J. LIBERTY (London) referred to the considerable mileage of arterial roads constructed since the war. The great width of these roads and the abolition of the speed limit inevitably led to acceleration of pace, and good lighting thereon was specially important. Much attention had been devoted to the construction and maintenance of first-class roads, but the inadequacy of the lighting was proverbial. Owing to the varying views taken by highway authorities in areas through which such roads passed well-lighted sections alternated with very dark ones, increasing the strain on the driver and making the use of headlights necessary—to the ultimate danger of the pedestrian. American street-lighting statistics had led to the conclusion that 17 per cent. of night accidents were attributable to inadequate lighting. The high degree of polish assumed by modern road surfaces meant that certain illumination and brightness of roadway were no longer directly related. With a view to preventing such conditions experiments with a coloured concrete surface on a section of the London-Fishguard Road were being made. In his concluding remarks Captain Liberty endorsed the plea made at the end of the paper for the appointment of qualified superintendents of public lighting. City engineers, borough engineers and chief constables, to whom this duty was frequently relegated, had other duties that were more than enough to occupy their time.

Mr. THOMAS WILKIE (Leicester) protested against Mr. Elford's suggestion that modern lighting was extravagant. Adequate lighting was abundantly justified, if only on account of the danger to life caused by defective lighting conditions. He would like to see every local official responsible for street lighting a member of the local Safety-First Committee, so that the value of proper illumination in preventing accidents might be better realized.

Mr. E. C. LENNOX (Newcastle) remarked that the proposal that no lamp of less than 500 candle-power should be adopted in main streets was somewhat indefinite. It should be indicated whether maximum or mean hemispherical candle-power, etc., was intended. In rural highways the use of directional reflectors was essential, but by taking suitable precautions in regard to the angle at which the main beam was directed, glare could be minimized. In regard to the surfacing of roadways, white-curbed highways were a material help to motorists at night. Good lighting on arterial roads helped considerably in securing an improved road factor. The cost of providing an adequate scheme of public lighting should not come to more than 2 per cent. of the capital cost of the arterial roadways, and 12 to 15 per cent. of the total maintenance cost of the roadways would suffice to enable a high standard of illumination to be maintained. In conclusion, Mr. Lennox remarked that the legislation relating to administration of public lighting in rural areas, which was substantially the same as that in practice in 1833, required revision. He welcomed, therefore, the suggestion made in the final portion of the paper, that an advisory council should be formed to deal with this matter.

Mr. J. F. COLQUHOUN (Sheffield) emphasized the beneficial effect of increasing the height of lamps in secondary streets to 13 feet, as had recently been done in Sheffield. This step had proved of great value to motorists in bringing the source of light out of the direct range of view. Experiments on road surfaces in Sheffield showed that considerable improvement could be secured by treatment with granite and quartzite chips. The latter gave the best results. The experiment of mounting automatic traffic control signals over the roadway had not proved satisfactory, and such signals were now placed at the sides of roads. Floodlighting was now being adopted at busy crossings, but the effect of the light would be better if the police officers were given white coats. Bright headlights were unnecessary on well-lighted streets; yet they were often used in this country in circumstances such that they would be prohibited in other countries. It seemed difficult to induce any body to take action, but possibly the R.A.C. might be induced to enlist the voluntary acquiescence of their members.

Mr. W. J. JONES expressed his appreciation of the paper. He agreed that simple advice in regard to methods of complying with the British Specification was needed, and he therefore welcomed the suggestion that lamps of not less than 500 candle-power should be used for main streets—though he appreciated the remarks made by Mr. Lennox in regard to the need for more explicit definition of candle-power. He would like to see a similar understanding in regard to lamps for other classes of streets. He agreed with Mr. Paterson that extreme uniformity of illumination was not in itself essential. The nature of the road surface had a great deal to do with the appearance of a street under artificial light. He suggested that when comparative tests were made the road surface should be identical; he recalled one recent experiment in which sanded roads were used for one display and untreated roads for another, which naturally affected the appearance materially! In regard to the figures quoted for street accidents in Edinburgh, he would like to know whether similar data for the period prior to the installation of automatic signals were available?

Lt.-Commander HAYDN T. HARRISON referred to the enormous difference in illumination available in

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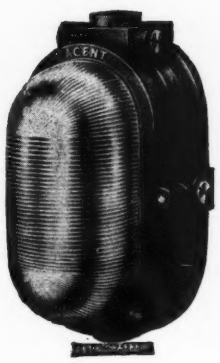

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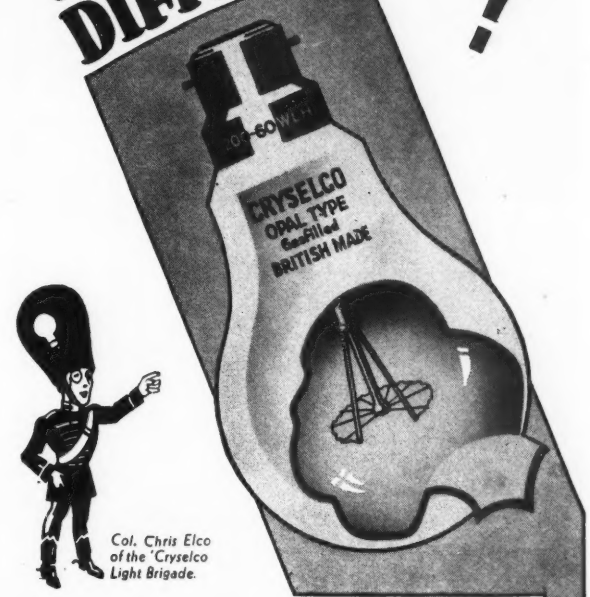

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streets during the day and at night-time. He thought it quite probable that as time went on the number of streets lighted to the class " A " standard would increase considerably. He had had some experience of the use of fixed headlights at the side of arterial roads, mentioned in the paper. The system had answered the needs of motorists very well, but had proved quite unacceptable to pedestrians. Central suspension had the drawback that the lamps were in the direct range of vision of people passing down the street, whereas side lamps were out of the direct range of vision and less liable to cause glare. He had found that central lamps at a height of 20 feet were equivalent in this respect to side lamps at a height of only 12 feet. Central suspension was only to be recommended in cases where the spacing did not exceed twice the width of the road.

Mr. E. KILBURN SCOTT said that public lighting engineers appeared to be bound by tradition and unable to break away from conventional methods. Originally lamps were mounted on posts mainly in order that the smoke and fumes they produced might be out of the way. At the present time posts were no longer necessary and lamps could be mounted in many ways, for example under diffusing glass at the sides of the kerbs.

Mr. HAROLD DAVIES, in reply, expressed his appreciation at the reception given to the paper, in the compilation of which a number of members of the Association had shared. It was perhaps a matter for discussion how far uniformity of illumination was desirable, but everyone was agreed that one should avoid abrupt contrasts. He did not agree with Mr. Elford that the demands of public lighting engineers were in any sense extravagant. It was true that the minimum illumination in Whitehall was stated to be as much as 2 foot-candles, but this was a unique case, and even so the illumination was only 1/250th of the full daylight illumination available. He agreed that central suspension was not practicable everywhere, but under certain conditions, for example in narrow streets bounded by high buildings, it was evidently the best method. In regard to Mr. Kilburn Scott's suggestion, he did not think that it was practicable at present to dispense with poles, which served the purpose of bringing the source to a sufficient height above the street. He could not imagine a thoroughfare being lighted solely from the kerb in the manner suggested.

A vote of thanks to the author was proposed by Mr. S. B. LANGLANDS (Glasgow), and a subsequent expression of thanks to the Chairman of the meeting (Mr. R. Beveridge) terminated the proceedings.

York House, Twickenham, floodlighted by gas.

York House, Twickenham, Floodlighted by Gas

The excellent photograph reproduced above shows the floodlighting by gas of the frontage of York House during the recent Twickenham Shopping Week. This house is said to have been the residence of James II. when Duke of York. It was occupied later by Louis Phillipe, Comte de Paris. Prior to the house being taken over by the Corporation to be used as the Municipal Offices of the Borough of Twickenham, it was occupied by Sir Ratanji Jamshedju Tata. The floodlighting of the frontage was effected by ten 10-light gas projectors. At the back of York House are some wonderful gardens. A feature is the statuary surrounding the lake, and this too was illuminated by five to ten-light gas projectors.

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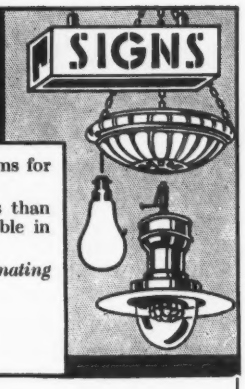

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Floodlighting of St. Mary's Church, Twickenham

Yet another effective example of floodlighting with gas is St. Mary's Church, the tower of which was illuminated also during Twickenham Shopping Week. This church is said to have been built by William of Wykeham. The portion of the church selected for floodlighting is the 14th century embattled tower. This tower contains a clock and a fine peal of eight bells, which were re-hung in 1925. The lighting is effected by five ten-light gas projectors, as shown in the above picture.

Practical Applications of Daylight Blue Lamps

(Contributed by the Lighting Service Bureau.)

IT is a well-known fact that the quality of the light emitted from the modern gasfilled lamp differs considerably from that of natural daylight, and in consequence the true colours of objects are not faithfully represented under ordinary artificial lighting. The daylight blue lamp was introduced to overcome this difficulty for processes and situations where colour discrimination is important, and since its introduction some few years ago many additional applications have come to light.

It is proposed in this article to indicate a few of the more popular uses of this light-source with a view to clearing up any misunderstanding that may exist.

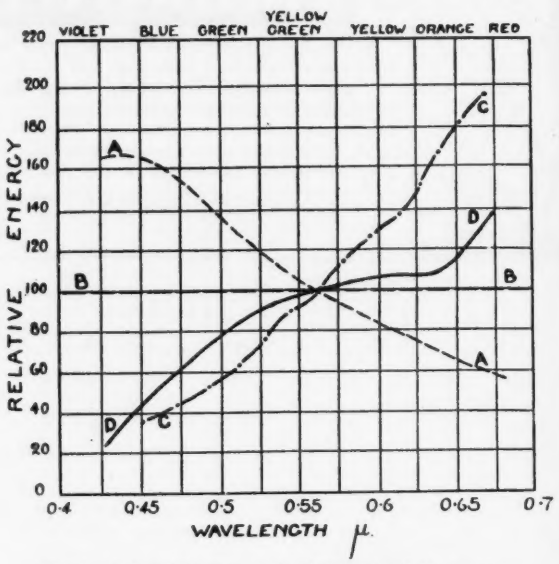
Owing to the fact that the blue bulb of the daylight lamp acts as a filter cutting out the excess of red and orange rays from the incandescent filament, care must be taken to provide an adequate intensity of light when installing these lamps. The loss of light due to the blue glass bulb is 35 to 40 per cent. Hence it is essential to install something like double the normal "clear lamp" wattage. Many installations of daylight blue lamps have failed owing to inadequate allowances of electric power.

One of the most interesting applications of these lamps is in the shop window. Although there is no apparent technical justification for their application in this sphere, many displays respond remarkably well. Flowers, cut glass, silver, white linen, dress shirts, etc., are some of the many things which definitely stand out better when lighted by daylight blue lamps. It is practically impossible to pass a florist's window which is well lighted in this way. The flowers appear very fresh and retain their natural colours, and the whole window stands well out from its neighbours. The daylight blue lamp can also be used with advantage in certain shop interiors, the florist again being an outstanding example.

There are many applications for daylight blue lamps in industry, and it is impossible to deal with them all in a paragraph. The grading of flour, tobacco, wheat, dried peas, chocolates, ball bearings and coal can all be carried out with greater speed and precision when corrected light of this character is employed. The dye and paint industries also find many applications for daylight blue lamps where colour-grading operations are carried out. An example from another important industry was the ironing department of a large laundry in which daylight lamps were installed. The introduction of these lamps led to a decrease in the number of scorch marks per given number of articles, due undoubtedly to the greater visibility of such discolorations under this light.

In floodlighting, daylight blue lamps can be used to pick out certain portions of an installation, such as a white cross on the top of a dome. They can also be used with great advantage when floodlighting gardens, parks, ornamental waters, etc., but cannot be recommended for general use.

A year or two ago, Imperial Chemical Industries erected a large office building at Millbank, London, particular attention being paid to the lighting. After a number of experiments it was decided that Imperial Chemical Industries should be lighted throughout by blue glass lamps. The additional expense incurred for extra wattage, and hence extra current consumption was, and still is, considered well worth while. In offices generally where conditions of half-daylight and half-artificial light are met, it is well worth while considering the installation of daylight lamps. They overcome the depressing psychological effect which is usually found when an office is lighted partly by artificial light and partly by daylight. It should be noted that this effect usually occurs during the winter when the office is most busy, that is between three and five o'clock, and tends to reduce efficiency.



Spectrophotometric Curves for Different Light Sources.
A—Light blue sky. C—Clear gasfilled lamp.
B—Noon sunlight. D—Daylight lamp.

In Trafalgar Square there is a sign advertising a well-known make of batteries which reproduces lightning in a very realistic manner. Daylight blue lamps are used in this sign and make it stand out from all neighbouring signs. For sheer individuality in sign displays daylight lamps or the lighter shade known as sign blue lamps are particularly effective, and the majority of signs can be given added appeal by equipping certain parts with these lamps. While on the subject of signs, it is interesting to note that many signwriters use daylight lamps for artificial illumination, as they enable more accurate selection and discrimination of colours.

The foregoing are but a few of the many practical applications of daylight blue lamps, but they must not be confused with those lighting problems where accurate colour-matching screens are necessary. The daylight blue lamp emits light of a colour which is only approximately that of daylight and can be used with advantage, as already outlined, where the cost of an accurate daylight installation cannot be justified.

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